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RELATIVE IMPORTANCE OF VARIOUS HOST PLANTS OF THE BEET LEAFHOPPER

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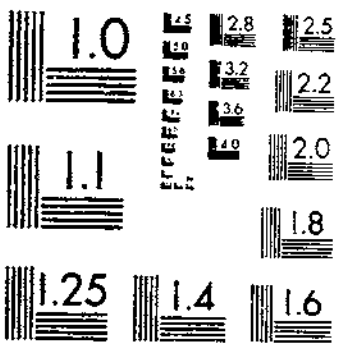

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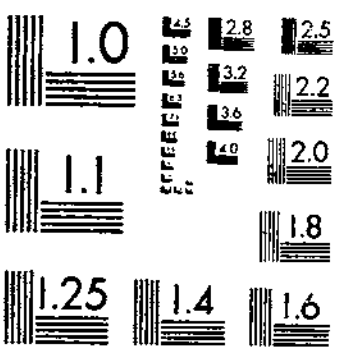

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Relative Importance of VARIOUS HOST PLANTS of the BEET LEAFHOPPER in *Southern Idaho*

by J. R. Douglass
and H. C. Hallock

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Relative Importance of VARIOUS HOST PLANTS of the BEET LEAFHOPPER in *Southern Idaho* [1]

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The importance of 43 spring and summer host plants of the beet leafhopper (*Circulifer tenellus* (Baker)) was studied in the spring breeding areas of southern Idaho, in the greenhouse, and in plots within a fenced area of about 18 acres near Berger, Idaho, in 1940–54. These studies covered the abundance of the host plants, the number of eggs deposited in the plant tissues, and the number of nymphs that developed.

Haegele (*3*) [4] recorded this leafhopper on approximately 40 host plants when he made collections extending 350 miles along the Snake River Plain. Carter (*1*) indicated the importance of a succession of host plants for each season of the year, as well as large areas of favorable hosts as breeding grounds for the production of high populations. Douglass and Cook (*2*) showed that the principal spring host plants were different in various breeding areas and that the host-plant complex was constantly changing.

The common and botanical names of the host plants used in this study are presented in table 1. The plants are distributed in 13 families, and there are 17 introduced species.

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[2] Retired May 1955.

[3] D. E. Fox, of the former Bureau of Entomology and Plant Quarantine, assisted in planning the study and did the major part of the work. R. L. Piemeisel, of the former Bureau of Plant Industry, Soils, and Agricultural Engineering, was a consultant in the study.

[4] Italic numbers in parentheses refer to Literature Cited, p. 11.

TABLE 1.—*Origin* [1] *and relationship of beet leafhopper host plants used in this study*

Common name	Botanical name	Family
African mustard*	*Malcolmia africana* (L.) R. Br	Cruciferae.
Black mustard*	*Brassica nigra* (L.) Koch	Do.
Blistercress*	*Erysimum repandum* L.	Do.
Brittleweed	*Chorizanthe watsoni* Torr. & Gray	Polygonaceae.
Curled dock*	*Rumex crispus* L.	Do.
Cut-leaved nightshade	*Solanum triflorum* Nutt	Solanaceae.
Dwarf phlox	*Phlox gracilis* (Dougl.) Greene	Polemoniaceae.
Falseflax*	*Camelina microcarpa* Andrz.	Cruciferae.
Fanweed*	*Thlaspi arvense* L.	Do.

See footnote at end of table.

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TABLE 1.—*Origin*[1] *and relationship of beet leafhopper host plants used in this study*—Continued

Common name	Botanical name	Family
Fiddleneck	*Amsinckia tessellata* A. Gray	Boraginaceae.
Filaree*	*Erodium cicutarium* (L.) L'Her	Geraniaceae.
Fireweed	*Gayophytum ramosissimum* Torr. & Gray.	Onagraceae.
Flixweed*	*Descurainia sophia* (Lam.) Webb	Cruciferae.
Globe nieveta	*Cryptantha circumcissa* (Hook. & Arn.) Johnst.	Boraginaceae.
Goosefoot	*Chenopodium leptophyllum* Nutt	Chenopodiaceae.
Greasewood	*Sarcobatus vermiculatus* (Hook.) Torr.	Do.
Green tansymustard	*Descurainia pinnata* var. *filipes* (A. Gray) Peck.	Cruciferae.
Hares-ear-mustard*	*Conringia orientalis* (L.) Dum.	Do.
Hutchinsia	*Hutchinsia procumbens* (L.) DC	Do.
Knotgrass*	*Polygonum aviculare* L.	Polygonaceae.
Mousetail	*Myosurus aristatus* Benth.	Ranunculaceae.
Narrow-leaved pectocarya.	*Pectocarya penicillata* (Hook. & Arn.) A. DC.	Boraginaceae.
Nieveta	*Cryptantha ambigua* (A. Gray) Greene	Do.
Patata	*Monolepis nuttalliana* (Schult.) Greene.	Chenopodiaceae.
Perfoliate pepperweed*	*Lepidium perfoliatum* L.	Cruciferae.
Prickly lettuce*	*Lactuca serriola* var. *integrata* Gren. & Godr.	Compositae.
Rabbitbrush	*Chrysothamnus* sp.	Do.
Redscale*	*Atriplex rosea* L.	Chenopodiaceae
Russian-thistle*	*Salsola kali* var. *tenuifolia* Tausch	Do.
Sagebrush	*Artemisia tridentata* Nutt	Compositae.
Siberian mustard*	*Chorispora tenella* (Pall.) DC	Cruciferae.
Sinuate gilia	*Gilia sinuata* Dougl.	Polemoniaceae.
Small-flowered evening-primrose.	*Oenothera minor* var. *cusickii* Munz	Onagraceae.
Small-flowered gilia	*Gilia minutiflora* Benth	Polemoniaceae.
Small pepperweed	*Lepidium densiflorum* Schrad	Cruciferae.
Smotherweed*	*Bassia hyssopifolia* (Pall.) Kuntze	Chenopodiaceae.
Stickleaf	*Mentzelia albicaulis* (Hook.) Torr. & Gray.	Loasaceae.
Stickseed	*Lappula* spp.	Boraginaceae.
Tobacco	*Nicotiana attenuata* Torr.	Solanaceae.
Tumblemustard*	*Sisymbrium altissimum* L.	Cruciferae.
Tumbleweed	*Amaranthus graecizans* L.	Amaranthaceae.
Wild snapdragon	*Collinsia parviflora* Dougl.	Scrophulariaceae.
Woolly gilia	*Gilia wilcoxii* Nels.	Polemoniaceae.

[1] Asterisks (*) indicate introduced species; all others are native.

Host Plants in Spring Breeding Areas

Observations on the abundance of host plants in the spring breeding areas of southern Idaho were made each spring incidental to studies to determine the population of beet leafhoppers that had overwintered and the relationship of host-plant abundance to the number of spring-generation leafhoppers moving into the cultivated areas in 1945–54. Records were made of the host plants sufficiently abundant to be included in the sampling areas of each observation point, their general condition, and the predominant host. These records were made at

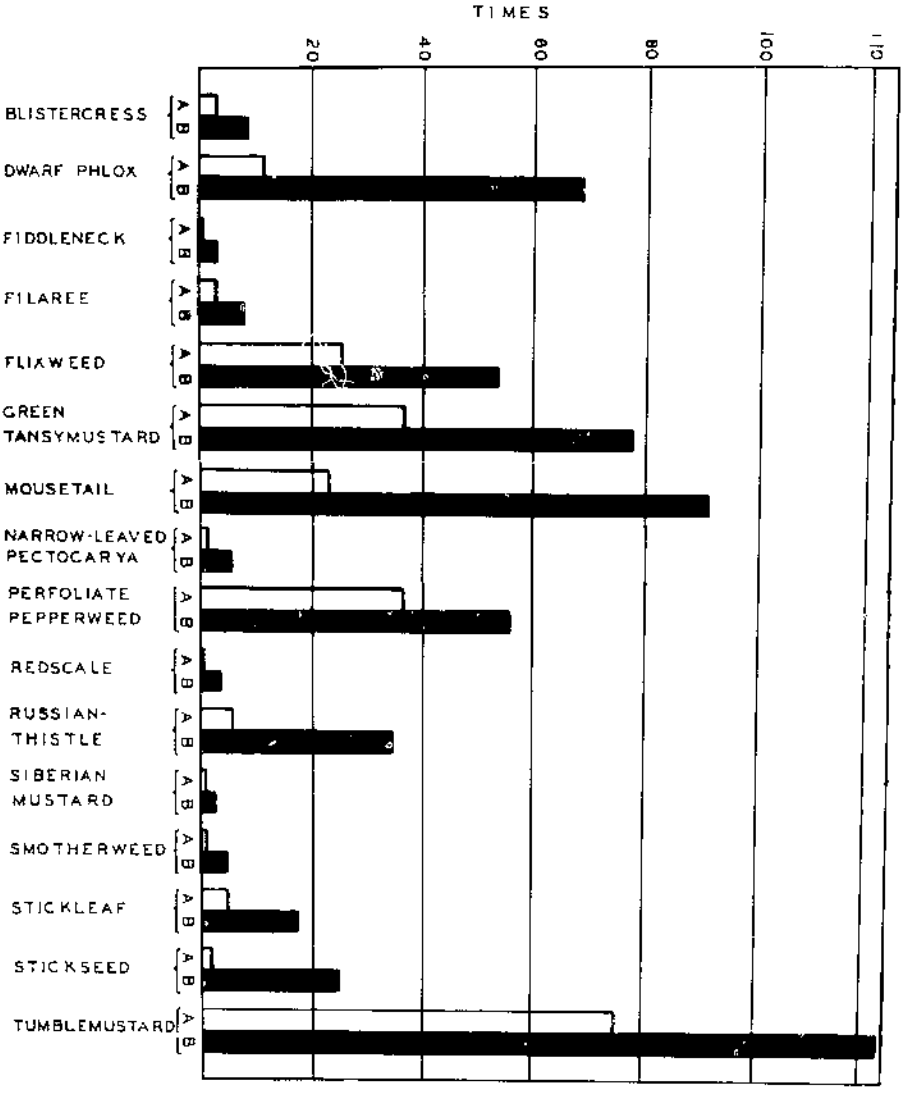

FIGURE 1.—Average abundance of 16 beet leafhopper host plants in the southern Idaho spring breeding areas during 1945–54, showing number of times predominant (*A*) and recorded (*B*).

2,262 stops, from 118 to 300 each year, depending on the abundance of the host plants, which were found to be numerous, widespread, and favorable for the production of a large population of spring-generation leafhoppers during 7 of the 10 years studied.

The average relative abundance of 16 host plants during early spring in 1945–54 is shown in figure 1. Dwarf phlox and mousetail were recorded at 30 to 40 percent of the stops and were often the predominant hosts, but as they generally matured and dried early in the spring,

the nymphs were forced to seek other hosts to complete their development. Redscale, Russianthistle, and smotherweed were summer hosts and were abundant at only a few localities in the spring breeding areas. Tumblemustard, perfoliate pepperweed, and flixweed were important in burned, overgrazed, or deteriorated rangeland, but tumblemustard was the most abundant. Green tansymustard was the most important host in the sagebrush areas.

Blistercress, filaree, and Siberian mustard were confined to locations in burned or disturbed rangeland. Narrow-leaved pectocarya and stickseed were generally found in the sagebrush areas, and their appearance depended on the amount of moisture early in the season. Stickleaf was found in the sandy portions of the leafhopper breeding area.

There were large areas where perfoliate pepperweed was growing in pure stands. The spraying of these areas in 1950, 1951, and 1953 reduced the leafhopper population more than 93 percent and was an important factor in its control. The average spring-generation population on this host was 33 leafhoppers per square foot in 1950 and 85 in 1953. Approximately 10,550 acres of perfoliate pepperweed were sprayed in 1953, which was 92 percent of the total acreage sprayed in that year.

Greenhouse Studies

The relative attractiveness of 19 plants, which were annuals except as hereafter noted, to ovipositing beet leafhoppers was studied under greenhouse conditions in 1940. Preliminary tests to develop methods were conducted in 1938 and 1939 but not reported here. The plants were grown from seed, transplanted to 3-inch flowerpots, and used when they were 2 to 3 inches tall or had rosettes of leaves 2 to 4 inches in diameter. The plants were arranged in 4 groups according to the size attained under growing conditions in the greenhouse. Field studies reported elsewhere in this bulletin show that some of these plants were spring, summer, or winter hosts of the leafhopper. Since it was difficult to obtain plants of the same size, the volume was measured and the number of eggs per plant corrected by analysis of covariance.

In each test the plants were exposed in a cage 30 inches square to about 3 gravid leafhoppers per plant for 4 to 6 days, depending on the temperature and the amount of sunlight. The plants were randomized in the cages, and there were 6 to 27 replicates in each experiment. The volume of the plants was measured after each test, the plant tissue cleared in a saturated solution of chloral hydrate in benzene, and a record made of the number of eggs in each plant.

The average number of eggs deposited in the tissue of each plant is shown in figure 2. Since tumblemustard is the most abundant host in the field, it was included in all 4 groups so that its attractiveness to ovipositing leafhoppers could be compared with that observed for the other hosts studied. The average number of eggs per plant in tumblemustard varied from 3 to 31 in the 4 groups. The lowest average was recorded in group B, where many of the species were attractive to ovipositing leafhoppers, and the highest in group C, where perfoliate pepperweed was the only attractive species. Curled dock (a biennial), blistercress, green tansymustard, and perfoliate pepperweed were very attractive. Flixweed and small

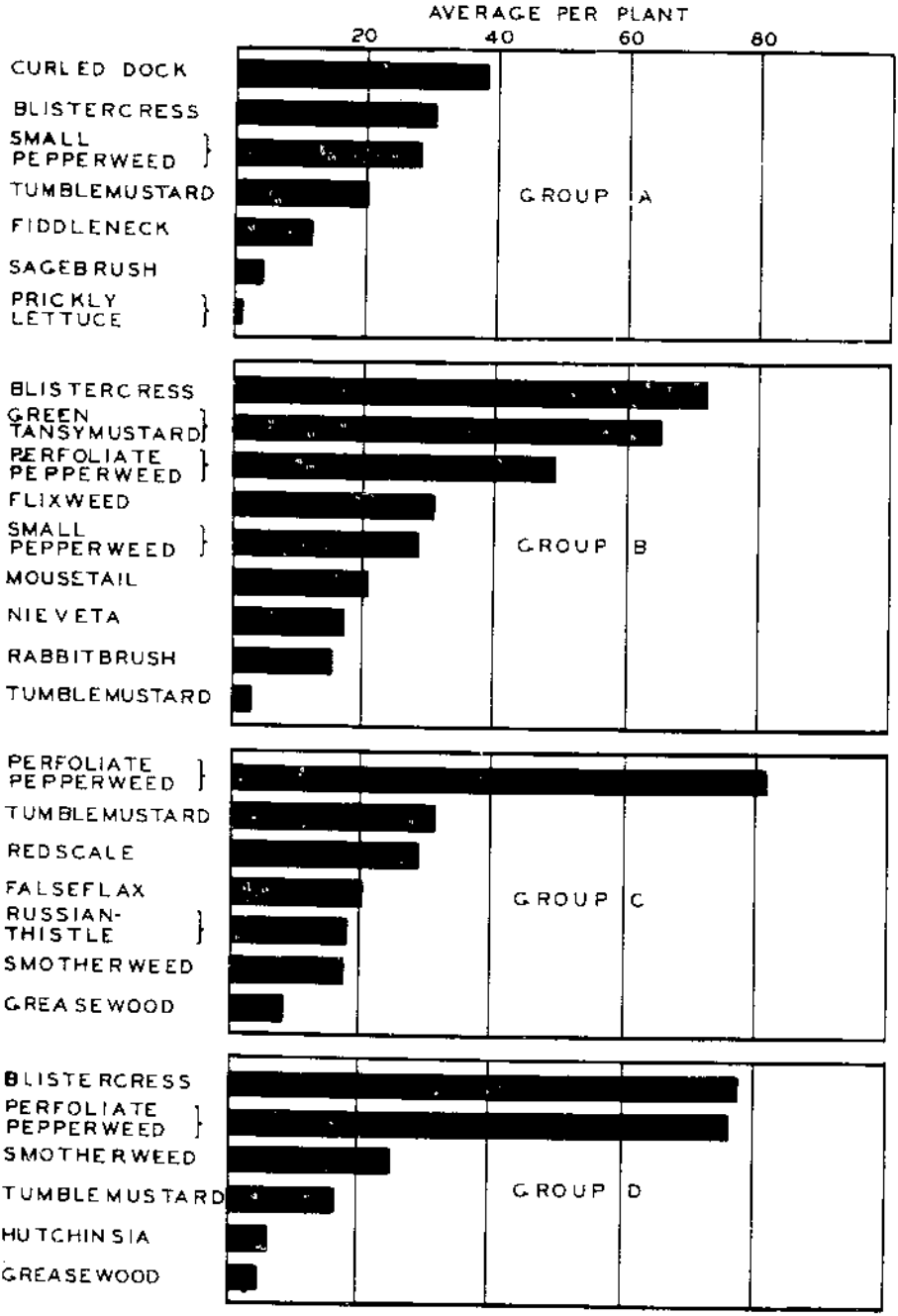

FIGURE 2.—Average number of beet leafhopper eggs deposited in the tissues of 19 host plants under greenhouse conditions, 1940.

pepperweed were moderately attractive, whereas mousetail, nieveta, falseflax, fiddleneck, and tumble-mustard were only fairly attractive. The perennials—sagebrush, grease wood, and rabbitbrush—which were often winter hosts, were unattractive to the ovipositing leafhoppers. Prickly lettuce and hutchinsia were the least attractive of the annuals. The summer hosts—redscale, Russian-thistle, and smotherweed—were less attractive than most of the spring hosts.

Plot Studies

The plot studies were designed to compare the abundance of leafhopper nymphs on some of the hosts observed in southern Idaho. This work was conducted during 1942–44 in an area southwest of Berger, which had been fenced against stock and rabbits. This area contained 85 plots, 40 by 50 feet, separated by 20-foot border strips (fig. 3). These strips were kept free from plants by cultivation. It was also necessary to use some cultivation within each plot to confine the plant growth to the single species planted there. The remainder of the fenced area consisted of a strip 105 by 1,320 feet, which was planted to flixweed to provide a relatively large area of a good spring and early-summer host plant near the plots. Seventy-five of the plots were included in a 5 by 5 lattice square, in which 25 plant species were replicated 3 times. The other 10 plots were planted to 10 species that were not replicated.

The population of leafhoppers developing in each plot was determined weekly by taking 10 samples with the half-square-foot sampling fork described by Lawson and others (*4*). A record was kept of the number of male and female adults and of the five instars of nymphs in each sample. Only nymphs were considered in comparing various plants as hosts of the leafhopper, since they do not move readily from one plot to another.

Because all the plants do not begin growth and reach maturity

FIGURE 3.—The Berger, Idaho, study area from the north end, June 17, 1943.

at the same time of the year, their suitability as hosts must be compared during the periods of availability. The entire spring-summer-fall period was divided arbitrarily into 3 seasons: (1) Early summer, from the time nymphs were first collected until July 7; (2) midsummer, from July 8 to August 15; and (3) late summer, from August 16 until sampling was terminated in the fall.

The periods when nymphs were recorded on each plant in the years when it was available on the plots are shown in figure 4. The length of these periods varied from 1 week for dwarf phlox to 20 weeks for Russian-thistle and smotherweed. The dates of the peak population of leafhopper nymphs have varied from June 10 in 1943 for dwarf phlox to October 5 in 1942 for small-flowered gilia.

Some difficulties were encountered in securing an ample stand of plants, but 16 species were sampled in all 3 years. Those sampled in 2 years included goosefoot, nieveta, Siberian mustard, sinuate gilia, small-flowered evening-primrose, stickleaf, and stickseed. Since green tansymustard and small pepperweed normally grow where there is a fair stand of sagebrush to give some protection, it was impossible to secure a sufficient stand of these 2 plants on the plots free from all other plants except during the first season.

The abundance of the beet leafhopper nymphs on each host plant during the early summer, midsummer, and late summer is shown in table 2. The nymphal population on the plants that were studied in all 3 years was compared statistically.

The highest average population during early summer was 1.7 nymphs per square foot on fanweed, which was significantly higher than on any other species except flixweed. Patata was the best host during midsummer, followed closely by rea-scale. Although African mustard supported only a low population in early summer, it was a good host

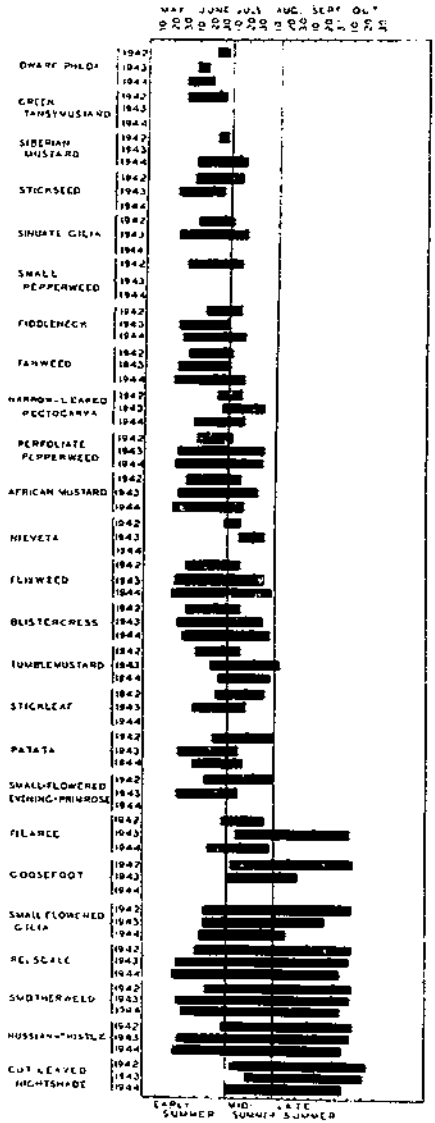

FIGURE 4.—Periods when beet leafhopper nymphs were observed on different plants in the Berger study area, 1942–44. The point on each line indicates the date of the peak population.

TABLE 2.—*Number of beet leafhopper nymphs per square foot of host-plant area on replicated plots in different seasons, 1942–44*

EARLY SUMMER

Plant	Nymphs		Plant	Nymphs	
	Peak	Average [1]		Peak	Average [1]
Fanweed	6.0	1.70	Fiddleneck	0.6	0.24
Flixweed	10.0	1.61	Russian-thistle	1.2	.14
Perfoliate pepperweed	5.6	1.12	Small-flowered gilia	.4	.10
Blistercress	4.8	1.06	Small-flowered evening-primrose	.6	*.08
Green tansymustard	6.0	*1.01	Siberian mustard	.6	*.05
Small pepperweed	1.0	*.75	Filaree	1.2	*.05
African mustard	5.4	.74	Dwarf phlox	.2	.02
Sinuate gilia	3.4	*.51	Cut-leaved nightshade	.2	*.01
Stickseed	2.6	*.39	Stickleaf	.2	*.01
Tumblemustard	1.8	.38	Nieveta	.2	*.01
Narrow-leaved pectocarya	6.0	.33	Least significant difference at 5-percent level		.36
Redscale	1.3	.32			
Patata	1.4	.29			
Smotherweed	.6	.25			

MIDSUMMER

Patata	43.4	6.22	Fanweed	15.2	1.36
Redscale	15.9	5.28	Filaree	6.2	1.13
Smotherweed	12.8	4.94	Nieveta	10.2	*1.11
Blistercress	24.6	3.26	Small-flowered evening-primrose	4.8	*1.02
Small pepperweed	16.2	*3.09	Stickseed	6.6	*.71
Russian-thistle	19.4	3.08	Small-flowered gilia	1.0	.68
Tumblemustard	11.0	2.79	Fiddleneck	4.6	.58
Flixweed	13.2	2.40	Siberian mustard	2.6	*.23
African mustard	18.8	2.27	Stickleaf	.8	*.14
Narrow-leaved pectocarya	12.6	2.23	Sinuate gilia	2.4	*.11
Cut-leaved nightshade	6.8	1.90	Least significant difference at 5-percent level		1.07
Perfoliate pepperweed	7.4	1.56			
Goosefoot	4.9	*1.45			

LATE SUMMER

Smotherweed	29.2	10.00	Filaree	2.0	*0.70
Russian-thistle	36.2	9.68	Tumblemustard	9.6	*.38
Redscale	38.2	8.66	Small-flowered gilia	3.8	.21
Cut-leaved nightshade	33.2	8.11	Least significant difference at 5-percent level		2.76
Goosefoot	4.9	*1.06			

[1] Asterisks (*) indicate where significant difference does not apply, because the host plants were not available for sampling in all 3 years.

during midsummer. There was no significant difference during late summer between the average populations recorded on the 4 best hosts—smotherweed, Russian-thistle, redscale, and cut-leaved nightshade. In other extensive field studies populations on Russian-thistle generally averaged higher than on smotherweed.

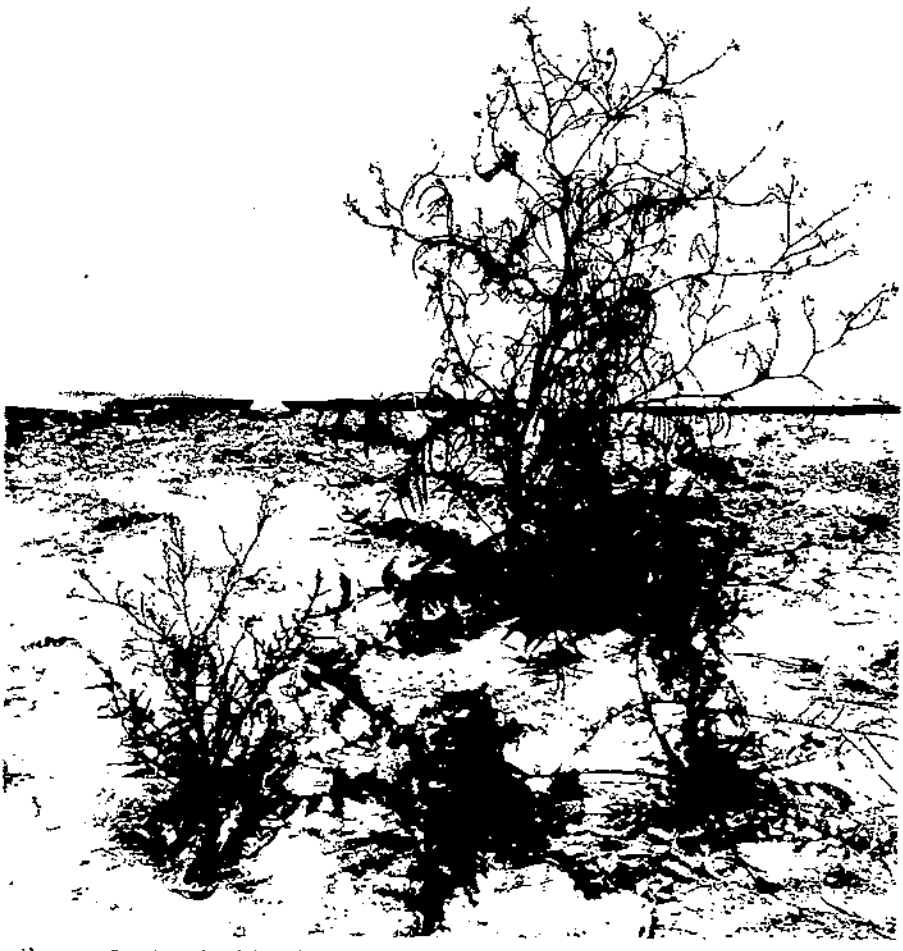

FIGURE 5. One healthy (back) and three diseased (front) tumblemustard plants.

Tumblemustard is generally classed as an early-summer and midsummer host. In this study it showed a peak population of 11 nymphs per square foot in midsummer. Since late rains in 1943 caused many plants to germinate later in the season, they were available for developing nymphs until August 20. These conditions have occurred during other seasons. As an example, in 1951 there were approximately 1,600 acres of tumblemustard in the Hollister area that remained green until September. Nearly a third of these green plants were dwarfed and twisted from an unknown disease that resembled aster yellows and curly top (fig. 5). These stunted plants were very favorable hosts for the beet leafhopper. Population counts made in this area on September 6 with the sampling fork showed an average of 5.4 leafhoppers per square foot on tumblemustard. Approximately 68 percent of these leafhoppers were in the nymphal stage.

The 10 plant species studied in

TABLE 3.—*Number of samples and beet leafhopper nymphs per square foot of host-plant area on unreplicated plots, 1942–44*

Plant	Samples	Nymphs	
		Peak	Average
Black mustard	40	42. 6	13. 50
Wild snapdragon	5	5. 4	3. 84
Tumbleweed	41	9. 4	1. 66
Hares-ear-mustard	12	4. 4	1. 37
Knotgrass	38	3. 6	. 83
Tobacco	9	2. 0	. 58
Globe nieveta	3	. 6	. 53
Woolly gilia	9	1. 0	. 42
Fireweed	5	. 8	. 28
Brittleweed	1	. 2	. 20

the unreplicated plots have generally not been sufficiently abundant in the breeding areas to be classed as important hosts. The results of this study are presented in table 3.

Black mustard, knotgrass, and tumbleweed produced sufficient stands to allow from 38 to 40 weekly sampling periods, but a high nymphal population was produced only on the black mustard. Medium populations were recorded on wild snapdragon, tumbleweed, hares-ear-mustard, and knotgrass. There have been several years when tumbleweed covered a considerable area. It was abundant south of King Hill in 1941 and west of Shoshone in 1954, and the leafhopper population on this host was similar to that on Russian-thistle in the Shoshone area. Low nymphal populations were recorded on knotgrass during the weekly sampling periods, but 23 percent were fifth-instar nymphs. Apparently small numbers can develop on this plant when its physiological condition is favorable, although in the greenhouse adults survived only a few days when caged on 8-inch knotgrass plants. Only a few nymphs were recorded on tobacco, globe nieveta, woolly gilia, fireweed, and brittleweed.

A review of the entire study shows that the species occurring in 2 plant families (table 1)—Chenopodiaceae and Cruciferae—have been important. These 2 families combined contained 44, 56, 63, and 46 percent, respectively, of the 43 plant species studied, of the 16 recorded in the spring breeding areas, of the 19 in the leafhopper-ovipositing study, and of the 35 used in the field plots. Tumblemustard, a Cruciferae, was the most abundant plant in the spring studies, was fairly attractive to ovipositing leafhoppers, and produced a medium population of nymphs on the plots. The highest populations in all 3 seasons of this study were produced on plants in these 2 families.

Thirty-nine percent of the plants in this study were introduced species. These species have become widely distributed, have been most attractive to ovipositing leafhoppers, and have produced the highest populations on the plots.

Summary

Forty-three plant species in southern Idaho were studied in 1940–54 to determine their relative importance as hosts of the beet leafhopper

(*Circulifer tenellus* (Baker)). These plants occurred in 13 families, but the Chenopodiaceae and Cruciferae were the most important. Studies were made in the spring breeding areas, in the greenhouse, and in field plots.

In burned, overgrazed, or deteriorated rangeland the most important host plants were flixweed, perfoliate pepperweed, and tumblemustard. In the sagebrush areas green tansymustard was the most important. Dwarf phlox and mousetail were recorded at 30 to 40 percent of the stops and were often the predominant host plants, but as they generally matured and dried early they were less important.

The greenhouse studies showed that curled dock, blistercress, green tansymustard, and perfoliate pepperweed were the most attractive species for egg laying. Flixweed and small pepperweed were moderately attractive to ovipositing leafhoppers.

In the plot studies nymphs were generally recorded for a shorter period on plants occurring in early summer than on plants growing in midsummer or late summer. The largest nymphal populations were produced on fanweed in early summer, patata in midsummer, and smotherweed in late summer. There was no significant difference between the nymphal populations developing on cut-leaved nightshade, redscale, Russian-thistle, and smotherweed during late summer.

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