Lygus Damage to Sugar Beet Seed In Various Stages of Development[1]

ORIN A. HILLS AND EDGAR A. TAYLOR[2]

Field-cage studies previous to 1945 (Hills *1, 2)*[3] showed that the feeding of lygus bugs *(Lygus oblineatus* (Say) , *L. hesperus* Knight, and *L. elisus* Van Duzee) was one factor responsible for the reduction in the viability of sugar-beet seed*. In that work the insects were encaged on sugar-beet plants about the time the first flowers opened and were allowed to remain until the seed matured. There was therefore no evidence of the stage of development of beet seed, between flower bud and seed maturity, during which lygus bug damage occurred. From 1945 to 1948, inclusive, experiments were conducted in field cages to determine at what stage of development beet seed was most susceptible to lygus bug injury. The purpose of this report is to present the results of a series of experiments begun in 1945, some of the preliminary results of which were discussed at a previous meeting of this Society in 1948.

Methods and Materials

The seed beets used in these experiments were of the curly-top-resistant variety known as U. S. 22. The cages used in 1945, 1946 and 1947 were cylindrical, 30 inches in diameter, 5 feet tall, and covered with open-mesh curtain scrim. Each cage enclosed the entire inflorescence of one sugar-beet plant. A group of these cages, in place on the plants, is shown in Figure 1.

In 1945 and 1946 75 cages were arranged in randomized block of 5 treatments and 15 replicates. Plants in four stages of seed development, from prebloom to nearly mature seed, were exposed to lygus infestations for 2 weeks. The first introductions were made into the cages when the plants reached the flower-bud stage; subsequent introductions were made at 2-week intervals. The fifth cage in each block was maintained insect-free as a check. Into each cage were placed 100 lygus bugs, a mixture of *L. hesperus* and *L. oblineatus*, gathered either from alfalfa or town mustard. At the end of the exposure period they were killed with DDT dust.

In 1947 72 cages were arranged in the field as randomized blocks of 6 treatments and 12 replicates. As in 1945 and 1946, 100 lygus bugs were introduced into cages containing plants in different stages of development. However, in 1945 and 1946 lygus were introduced into all cages of a given treatment on the same date, the date being selected when most of the plants in the series were in the desired stage of development. In 1947 lygus bugs

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[2] Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture. The Beet Sugar Development Foundation furnished a temporary assistant during the summers of 1946 to 1948. The University of Arizona cooperated in planting and maintaining the beet plots on which the experiments were conducted in 1947 and 1948.

[3] Numbers in parentheses refer to literature cited.

* Sugar-beet seed in commercial usage refers to seed balls, each of which may contain one or more true seeds. In this paper the common practice of referring to the seed balls collectively as "seed" is followed.

were introduced into each cage when the plant within that particular cage had reached the specified stage of development. The insects were then allowed to remain within the cage only 1 week instead of 2 weeks as in 1945 and 1946. As beet seed develop progressively on a plant (blooming beginning at the bases of the spikelets and proceeding toward the tips), there is never a time when all immature seed are in the same stage of development. The aim of the 1947 experiments was to confine the lygus infestations as closely as possible to the following development stages of the seed:

Figure 1. Field cages for **determination of lygus** damage **to** beet seed **in varying stages of development. 1945 to 1947.**

Prebud—Seed stalk mostly vegetative but flower buds beginning to develop.

Flower bud—Side branches developing on the seed spike and flower buds in evidence.

Early bloom—Side branches well developed on seed spike with open flowers at base of spikelets.

Full bloom—Maximum possible number of open flowers.

Early seed—Newly formed seed in central portion of spikelet with mature, hard seed toward base and a few open flowers toward the tip.

The sixth cage in each block was maintained insect-free as a check. Most of the lygus bugs used in this experiment were taken from alfalfa and were predominantly *L. hesperus* with a few *L. oblineaius.*

The experiments in 1948 differed from those in previous years in that all cages within a block were placed on a single seed-beet plant. This was

done in an effort to reduce the experimental error due to the normal variation between plants, and made necessary some changes in equipment, methods and arrangement of the experiment. During the winter months the seed beets to be used for this experiment were thinned to 1 foot apart, and as soon as bolting occurred in the spring the central stalk of each plant was removed to encourage the production of several seed stalks.

The cages used in 1948 were only 1 foot in diameter and 3 feet long. Each cage was suspended from a wooden frame as shown in Figure 2. One

Figure 2. One block of field cages in place on multiple-bolting seed beet. 1948.

hundred cages were arranged in the field as randomized blocks of 4 treatments and 25 replicates. The technique employed in 1948 reduced the quantity of seed per cage; therefore only 25 lygus bugs were used in a cage instead of 100. The insects were allowed to remain on the seedstalks for 1 week. On each plant one encaged seed-stalk was infested in the flower-bud stage of development, one in the full-bloom stage, and one in the soft-seed stage (Figure 3). The fourth was maintained insect-free as a check. The lygus

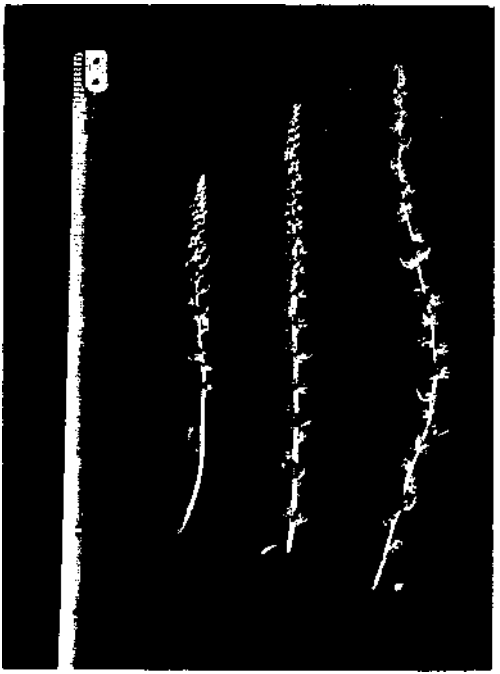

Figure 3. Seed-beet spikelets representing different stages of seed development during lygus infestations of 1948. From left to right these developmental stages were indicated as flower bud, full bloom, and soft seed.

bugs were obtained from alfalfa, as in 1947, and consisted largely of *L. hesperus* with an occasional *L. oblinealus.* They were introduced into each cage when the maximum number of seed therein was in the desired stage of development.

At maturity the seed from each cage was harvested, hand-threshed, and cleaned through a miniature mill over a 7/64-inch screen. Seed balls smaller than 7/64 inch in diameter were discarded. Yield was determined by weighing the cleaned seed, and viability was determined by germinating a sample of 400 seed balls from each cage. The germination tests included sprout counts to determine the percent of viable seed balls and the number of sprouts per viable ball.

Results and Discussion

Weather conditions in 1945 and 1946 were such that seed development in 1946 was more rapid than in 1945, as indicated in the first two columns of Table 1. These differences in plant development are reflected in the results of the experiment. Jn 1946 considerable soft seed was formed during the first exposure period and under these conditions seed viability and seed yield were reduced significantly. In 1945 seed development was slower, fewer soft seed formed during the first exposure period, and there were no significant reductions in seed viability or yield until the second exposure period. There were fewer sprouts per seed ball owing to lygus feeding during the first two exposure periods of both 1945 and 1946.

Table 1.—Viability and yield of sugar-beet seed on plants exposed at different stages of seed development to lygus infestation in field cages. Phoenix, Ariz., 1945 and 1946.

Seed development		Yield of seed per cage		Viable seed balls		Sprouts per viable seed ball	
1945	1946	1945 Grams	1946 Grams	1945 Percent	1946 Percent	1945 Number	1946 Number
Flower bud to full bloom	Flower bud to late bloom	87	39	74	42	1.36	1.21
Full bloom to late bloom and early seed	Late bloom to early seed	60	51	36	19	1.39	1.36
Late bloom and early seed to soft seed and maturing seed	Early seed to soft seed and maturing seed	90	67	47	64	1.55	1.63
Soft dough and maturing seed to late, hard, mature seed	Mostly mature seed	82	64	74	84	1.61	1.55
Insect-free cages (check)	Insect-free cages (check)	118	64	78	96	1.57	1.64
Difference required for significance ($P = 0.05$)		30	20	12	12	0.15	0.15

Results of the 1947 and 1948 experiments are summarized in Tables 2 and 3. These data show significant reductions both years for the percent of viable seed produced during the full-bloom and soft-seed stages of development. Although the maximum number of soft seed occurred in the cages during the full-bloom period. The reduction in the percent of viable

seed balls during these two periods for both years is approximately proportional to the number of soft seed present at the time of exposure to lygus. In 1948 there were significant reductions in the number of sprouts per ball during the full-bloom period. It is possible that lygus may have damaged individual flowers during the blooming period before the ovaries fused to form the seed ball. In 1947 and 1948 infestations before the full-bloom period did not produce a measurable effect on the developing beet seed. No significant reductions in seed yield are indicated for either 1947 or 1948.

Table 2.—Viability and yield of sugar-beet seed on plants exposed at different stages of development to lygus infestation in field cages. Phoenix, Ariz., 1947.

Seed development	Yield of seed per cage Grams	Viable seed balls Percent	Sprouts per viable seed ball Number
Prebud	80	98	1.80
Flower bud	83	98	1.86
Early bloom	89	96	1.71
Full bloom	87	87	1.68
Soft seed	104	66	1.61
Insect-free cages (check)	99	99	1.74
Difference required for significance ($P = 0.05$)	[1]	8	[1]

[1] Not significant by the F test.

Table 3.—Viability and yield of sugar-beet seed from seed stalks of the same plant exposed at different stages of seed development to lygus infestation in field cages. Tempe, Ariz., 1948.

Seed development	Yield of seed per cage Grams	Viable seed balls Percent	Sprouts per viable seed ball Number
Flower bud	42	94	1.48
Full bloom	41	89	1.43
Soft seed	40	83	1.50
Insect-free cages (check)	45	93	1.52
Difference required for significance ($P = 0.05$)	[1]	3	0.05

[1] Not significant by the F test.

Summary **and Conclusions**

In Arizona, from 1945 to 1948, experiments were conducted in field cages to determine the effect of lygus infestations on sugar-beet seed in different stages of development. The results of these experiments indicate that the primary damage of lygus to sugar-beet seed is the reduction in the percent of viable seed. These losses were also accompanied by a reduction in the number of sprouts per viable seed ball. Reductions in yield were indicated where lygus infestations were sufficiently severe, as in 1945 and 1946 when infestations consisted of 100 lygus per plant over a period of 2 weeks.

Results of these experiments further indicate that the greatest amount of damage is to the soft and newly formed seed. This is more clear-cut in the experiments of 1947 and 1948 than in the earlier experiments, since in 1947 and 1948 the infestations were of only 1 week's duration and also the introductions during the last 2 years were made to the plants individually in the desired stage of development. Results of the 1947 experiments showed that there was no damage in the prebud, flower-bud, or early bloom stages of development. There was some damage in 1947 and 1948 from lygus infestations on plants in the full-bloom stage, but the maximum damage occurred from infestations in the late-bloom to early seed stage of development. Some soft seed occurred in those cages in which infestations were made during the period designated as full bloom, but greater damage occurred during the infestation period designated as soft seed. It is therefore probable that the damage in the preceding infestation period was largely to the soft seed present on the plants at that time.

In 1945 and 1946, when infestation periods were of 2 weeks' duration and infestations were made on the same date to all plants within a treatment, the results are not so clearcut as in 1947 and 1948. However, when one considers the overlapping of plant development and the fact that the damage was greatest within the cages containing the largest number of soft seed during the infestation period, the data corroborate those of 1947 and 1948 and indicate again that the greatest amount of damage from lygus may be attributed to infestations in the early seed stage of development. In both 1945 and 1946 the last infestations were made to plants in later stages of seed development than in 1947 and 1948. These infestations to mature or nearly mature seed caused little or no damage. Likewise, infestations in 1947 and 1948 to plants before the blooming period resulted in no damage.

Literature Cited

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