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FS 905

Economic Thresholds in Soybeans

Grasshopper and Bean Leaf Beetle

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Economic injury level (EIL)

The number of insect pests in the field representing the breakeven point between the cost of control and the value of the damage that will be prevented if a control action is taken.

Economic threshold (ET)

The number of insect pests in the field representing the actual time at which control actions must be taken to prevent the EIL from being reached and exceeded.

Indirect indicators of insect numbers such as percent leaf defoliation or number of pods destroyed per linear foot also can be used instead of actual insect numbers to determine EIL and ET.

If control measures can be taken without delay, then EIL and ET are one and the same. ET recognizes the fact that a lead time is usually needed from when damaging insect numbers are detected in the field to the actual application of a control tactic.

Integrated pest management (IPM)

A comprehensive approach to pest control that uses combined means to reduce the status of pests to tolerable levels while maintaining a quality environment.

The main objective of IPM is to avoid economic loss. Complete elimination of the pest is not attempted and a certain pest population, below the economic injury level, is tolerated.

IPM promotes the use of several tactics such as insecticides, crop rotation, biological control, planting dates manipulation, harvest management, and the use of pest-resistant varieties to reduce pest populations below economic levels.

Overuse of a single control tactic is discouraged to avoid or delay the development of resistance by the pest to the control tactic, to minimize damage to nontarget organisms, and to preserve the quality of the environment.

General Guidelines

This publication is intended for use by county Extension educators, pesticide dealers, consultants, commercial applicators, and producers in South Dakota. Recommendations are current at the time of printing.

Mention of trade names does not imply endorsement of any product over another or discrimination against a similar product. Always read and follow label directions and precautions.

Most insecticides are capable of causing injury to applicators if not handled properly. Always wear protective gear as specified on the product label. Avoid contact of the insecticide with the skin, mouth, nose, eyes, and clothing. Bathe and wash clothing after exposure to any insecticides. Wash clothing on which insecticide residues may have accumulated before wearing again. Wash contaminated clothing separately from other household laundry.

In case of accidental poisoning call: 1-800-764-7661 (Sioux Valley Regional Poison Control Center).

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Grasshoppers

The redlegged, twostriped, and differential grasshoppers are the most common species infesting soybeans in South Dakota. Female grasshoppers lay eggs in the soil from late-August until the first killing frost in the fall. Eggs of the twostriped and differential grasshoppers hatch from late-May through June.

Hatching of the redlegged grasshoppers start in late-June and continues until mid-August. Thus, grasshoppers of various ages and species are always present in soybean fields during the growing season. Grasshoppers are mainly leaf consumers or defoliators of soybeans.

Economic injury levels (EIL)

Soybeans can tolerate a certain degree of defoliation without affecting yield. However, soybeans are vulnerable to grasshoppers and other leaf-feeding insects during the pod-fill stages. The equations for calculating the EIL of grasshoppers on soybeans are outlined below (Kalton et al. 1949, Stone and Pedigo 1972):

$$\text{Gain threshold} = \frac{\text{control cost in \$ per acre}}{\text{market value in \$ per bushel}}$$

$$\text{GTP} = \frac{\text{gain threshold} \times 100}{\text{expected yield in bushels per acre}}$$

$$\text{EIL (\% defoliation, } \textbf{vegetative stages}) = \frac{\sqrt{(\text{GTP})(0.008) + (0.000841)} + 0.029}{0.004}$$

$$\text{EIL (\% defoliation, } \textbf{pod-fill stages}) = \frac{\sqrt{(\text{GTP})(0.032) + (0.001024)} - 0.032}{0.016}$$

Economic threshold (ET)

Action must be taken once a certain level of insect numbers is observed in the field so that the EIL is not exceeded. That is, sufficient lead time is needed from the time an economic number is observed to the time when a treatment is actually applied on the field. ET can be calculated as: ET = 80% of the EIL.

Example 1

A soybean grower from Bath, SD, is concerned about grasshoppers feeding on the field. Soybeans are at the V1 or one-trifoliate stage of development. The predicted market value of the crop is $5/bu and the crop sprayer is charging $12/acre for insecticide plus application. Expected yield is 40 bu/acre. At what grasshopper defoliation level should the grower initiate action to control grasshoppers?

$$\text{Gain threshold} = \frac{\text{control cost}}{\text{market value}} = \frac{\$12 / \text{acre}}{\$5 / \text{bu}} = 2.4 \text{ bu / acre}$$

$$\text{GTP} = \frac{\text{gain threshold} \times 100}{\text{expected yield in bu per acre}} = \frac{2.4 \text{ bu / acre} \times 100}{40 \text{ bu / acre}} = 6\ \%$$

$$\text{EIL (\% defoliation, } \textbf{vegetative stages}) = \frac{\sqrt{(6)(0.008) + (0.000841)} + 0.029}{0.004}$$

EIL = 62.5 % defoliation

ET = 0.8 X 62.5 = **50 % defoliation**

Example 2

A soybean grower from Lucas, SD, is concerned about grasshoppers feeding on his field which is at the R5 or at the beginning of pod-fill stage of development. The predicted market value of the crop is $5/bu, control cost is $12/acre for insecticide plus application, and the expected yield is 40 bu/acre. At what grasshopper defoliation level should the grower initiate action to control grasshoppers?

$$\text{Gain threshold} = \frac{\text{control cost}}{\text{market value}} = \frac{\$12 / \text{acre}}{\$5 / \text{bu}} = 2.4 \text{ bu / acre}$$

$$\text{GTP} = \frac{\text{gain threshold} \times 100}{\text{expected yield in bu per acre}} = \frac{2.4 \text{ bu /acre} \times 100}{40 \text{ bu / acre}} = 6\ \%$$

$$\text{EIL (\% defoliation, } \textbf{pod-fill stages}) = \frac{\sqrt{(6)(0.032) + (0.001024)} - 0.032}{0.016}$$

EIL = 25.4 % defoliation

ET = 0.8 X 25.4 = **20.3 % defoliation**

Estimating percent defoliation

Percent defoliation can be easily and accurately estimated using a 5x5-to-the-inch (or any other grid size) graphing paper. A graphing paper copied onto a transparency would be ideal and can be reused. The procedures are as follows:

1) Collect a representative number of soybean trifoliates from the field. Collect at least 20 trifoliates

from 20 random plants per 40 acre field. More samples will give more accurate estimates.

2) Discard the most and least damaged leaflets in each trifoliate. Save the remaining 20 leaflets.

3) Place a transparent 5x5-to-the-inch (or any other grid size) graphing paper over the leaflet to be measured (see Figures 1–2 for examples).

4) Count the total number of square cells occupied by the leaf area (as if the leaflet were undamaged). Count only cells that are at least 50% covered by the leaf area.

5) Count the number of cells occupied by the missing leaf tissues. Count only cells that are at least 50% empty.

6) Calculate percent defoliation as:

$$\%\text{Defoliation} = \frac{\text{No. missing cells x 100}}{\text{Total no. cells occupied}}$$

When to take action (if ever)

Initiate an insecticide control action only when the economic threshold (ET) is reached. Because the cost of insecticides plus application, potential yield, and the predicted market value of soybean are all considered in calculating ET, control actions will be dynamic and variable. Table 1 lists the common insecticides for use against grasshoppers on soybean in South Dakota.

Remember that there will be times when the appropriate action is to do nothing: that is, when the the worth of the damage that will be prevented by spraying is not high enough to offset the cost of the chemical and application.

Table 1. Insecticides for grasshopper control on soybeans.

Brand name	Active ingredient	Product per acre
Asana XL *	esfenvalerate	5.8-9.6 fluid ounces
Dimethoate 400	dimethoate	1 pint
Furadan 4F *	carbofuran	0.25-0.50 pint
Karate *	lambda-cyhalothrin	3.20-3.84 fluid ounces
Lorsban 4E	chlorpyrifos	0.5-1.0 pint
Scout X-TRA *	tralomethrin	2.3-3.3 fluid ounces
Sevin XLR PLUS	carbaryl	1-3 pints
Warrior T *	lambda-cyhalothrin	3.20-3.84 fluid ounces

* Restricted use insecticide.

Bean leaf beetles

Bean leaf beetles are fast becoming an important pest of soybeans in South Dakota. They are very hardy and can survive the winter as adult beetles in shelterbelts, leaf litters, and soil crevices on the field. In the spring, bean leaf beetles start feeding on alfalfa and other legumes before moving into soybeans.

Adult beetles are seen on the field throughout the growing season. Overwintered beetles (actually the second brood from last year) and the first and second broods overlap in the field. Larvae of the bean leaf beetles feed on soybean roots and nodules but are not considered pests at this time.

Bean leaf beetles, like grasshoppers, are primarily leaf consumers. Defoliation during the seedling and vegetative stages of soybean seldom reach economic threshold levels. However, defoliation levels during these stages must still be monitored by the grower, especially if grasshoppers are also present on the field.

Bean leaf beetles are most important during the "green bean" reproductive stage of soybeans. At this stage, bean leaf beetles may continue feeding on the leaves, clip the developing pods from the stem, or feed directly on the seed pods. Pod feeding may eventually result in discolored, wrinkled, or moldy seeds during harvest.

Economic Injury Levels (EIL)

Apply the equations above used for grasshopper defoliation to decide whether to treat bean leaf beetles during soybean stages prior to the "green bean" stage.

Below are specific procedures for determining thresholds for bean leaf beetles once the soybean plants reach the "green bean" stage of development in the field. These procedures were developed by Smelser and Pedigo (1992) of Iowa State University.

$$\text{Gain threshold} = \frac{\text{control cost in \$ per acre}}{\text{market value in \$ per bushel}}$$

$$\text{GTP} = \frac{\text{gain threshold x 100}}{\text{expected yield in bushels per acre}}$$

$$\text{EIL (beetle per foot of row)} = \frac{\text{GTP x 7.6}}{\text{loss per insect}} = \frac{\text{GTP x 7.6}}{3.88\%}$$

$$\text{EIL (beetle per sweep of net)} = \frac{\text{GTP x 7.6 x 0.62}}{3.88\%}$$

Economic threshold (ET)

Action must be taken once a certain level of insect numbers is observed in the field so that the EIL is not exceeded. That is, sufficient lead time is needed from the time an economic number is observed to the time when a treatment is actually applied on the field. ET can be calculated as follows: ET = 80% of the EIL.

Special consideration for drilled soybeans: The equations above for bean leaf beetles were developed for 30-inch row soybeans and 7.6 plants per foot of row. For 8-inch row or drilled soybeans, multiply the calculated ET by 0.7 to account for the higher plant density.

Example 3

A crop consultant from Platte, SD, is concerned about bean leaf beetles feeding on the field. The drilled soybean is at the "green bean" stage of development. Predicted market value of the crop is $5/bu and the crop sprayer is charging $12/acre for insecticide plus application. Expected yield is 40 bu/acre. How many bean leaf beetles per sweep of an insect net should be seen on the field before control actions are initiated?

$$\text{Gain threshold} = \frac{\text{control cost}}{\text{market value}} = \frac{\$12/\text{acre}}{\$5/\text{bu}} = 2.4 \text{ bu/acre}$$

$$\text{GTP} = \frac{\text{gain threshold x 100}}{\text{expected yield in bu per acre}} = \frac{2.4 \text{ bu/acre x 100}}{40 \text{ bu/acre}} = 6\%$$

$$\text{EIL (beetles per sweep of net)} = \frac{\text{GTP x 7.6 x 0.62 x 0.7}}{3.88} = 5.1$$

EIL = 5.1 beetles per sweep of net

ET = 0.8 x 5.1 = **4.1 beetles per sweep of net**

Example 4

An agronomy educator from Aberdeen, SD, is concerned about bean leaf beetles feeding on a soybean field in the "green bean" stage of development. Soybeans were planted in 30-inch rows. The predicted market value of the crop is $5/bu, control cost is $12/acre for insecticide plus application, and the expected yield is 40 bu/acre. How many beetles per foot of row must be present on the field before control actions are initiated?

$$\text{Gain threshold} = \frac{\text{control cost}}{\text{market value}} = \frac{\$12/\text{acre}}{\$5/\text{bu}} = 2.4 \text{ bu/acre}$$

$$\text{GTP} = \frac{\text{gain threshold x 100}}{\text{expected yield in bu per acre}} = \frac{2.4 \text{ bu/acre x 100}}{40 \text{ bu/acre}} = 6\%$$

$$\text{EIL (beetles per foot of row)} = \frac{\text{GTP x 7.6}}{3.88} = \frac{6 \text{ x 7.6}}{3.88} = 11.8$$

EIL = 11.8 beetles per foot of row

ET = 0.8 x 11.8 = **9.4 beetles per foot of row**

Table 2. Insecticides for bean leaf beetle control on soybeans.

Brand name	Active ingredient	Product per acre
Ambush *	permethrin	3.2-6.4 fluid ounces
Asana XL *	esfenvalerate	5.8-9.6 fluid ounces
Chlorpyrifos 4E AG	chlorpyrifos	1-2 pints
Dimethoate 400	dimethoate	1 pint
Lorsban 4E	chlorpyrifos	1-2 pints
Pounce 3.2 EC *	permethrin	2-4 fluid ounces
Sevin XLR PLUS	carbaryl	1-2 pints
Warrior T *	lambda-cyhalothrin	3.20-3.84 fluid ounces

* Restricted use insecticide.

References

Smelser, R. B. and L. P. Pedigo. 1992. Soybean seed yield and quality reduction by bean leaf beetle (Coleoptera: Chrysomelidae) pod injury. J. Econ. Entomol. 85: 2399-2403.

Stone, J. D. and L. P. Pedigo. 1972. Development and economic-injury level of the green cloverworm on soybean in Iowa. J. Econ. Entomol. 65: 197-201.

Kalton, R. R., C. R. Weber and J. C. Eldredge. 1949. The effect of injury simulating hail damage to soybeans. Iowa Agr. Home Econ. Exp. Sta. Bull. 359: 736-796.

Rudd, W. G. and R. L. Jensen. 1977. Sweep net and ground cloth sampling for insects in soybeans. J. Econ. Entomol. 70: 301-304.

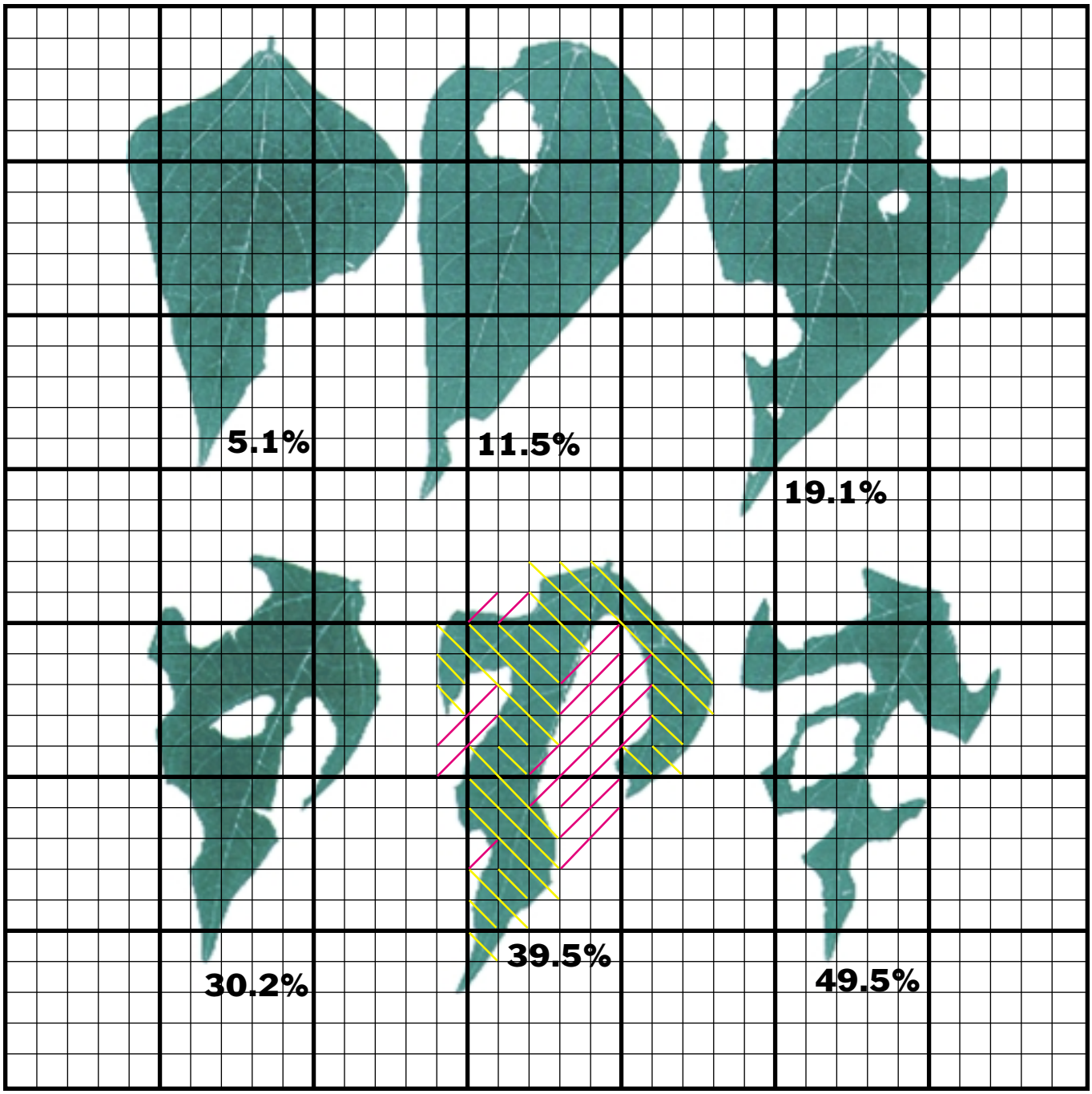


Figure 1. Sample leaf defoliation levels of late-vegetative stage soybean caused by grasshoppers. Percent defoliation below each leaf was determined using an electronic leaf area meter (J. Barrigossi, University of Nebraska). Accurate estimation also can be obtained by counting each cell occupied (50% or more) by the missing and total areas of the leaf sample as illustrated above. Refer to "Estimating percent defoliation" for procedures in measuring defoliation using the graphing paper technique (—cell at least 50% occupied by a normal leaf tissue, —cell at least 50% occupied by a missing leaf tissue).

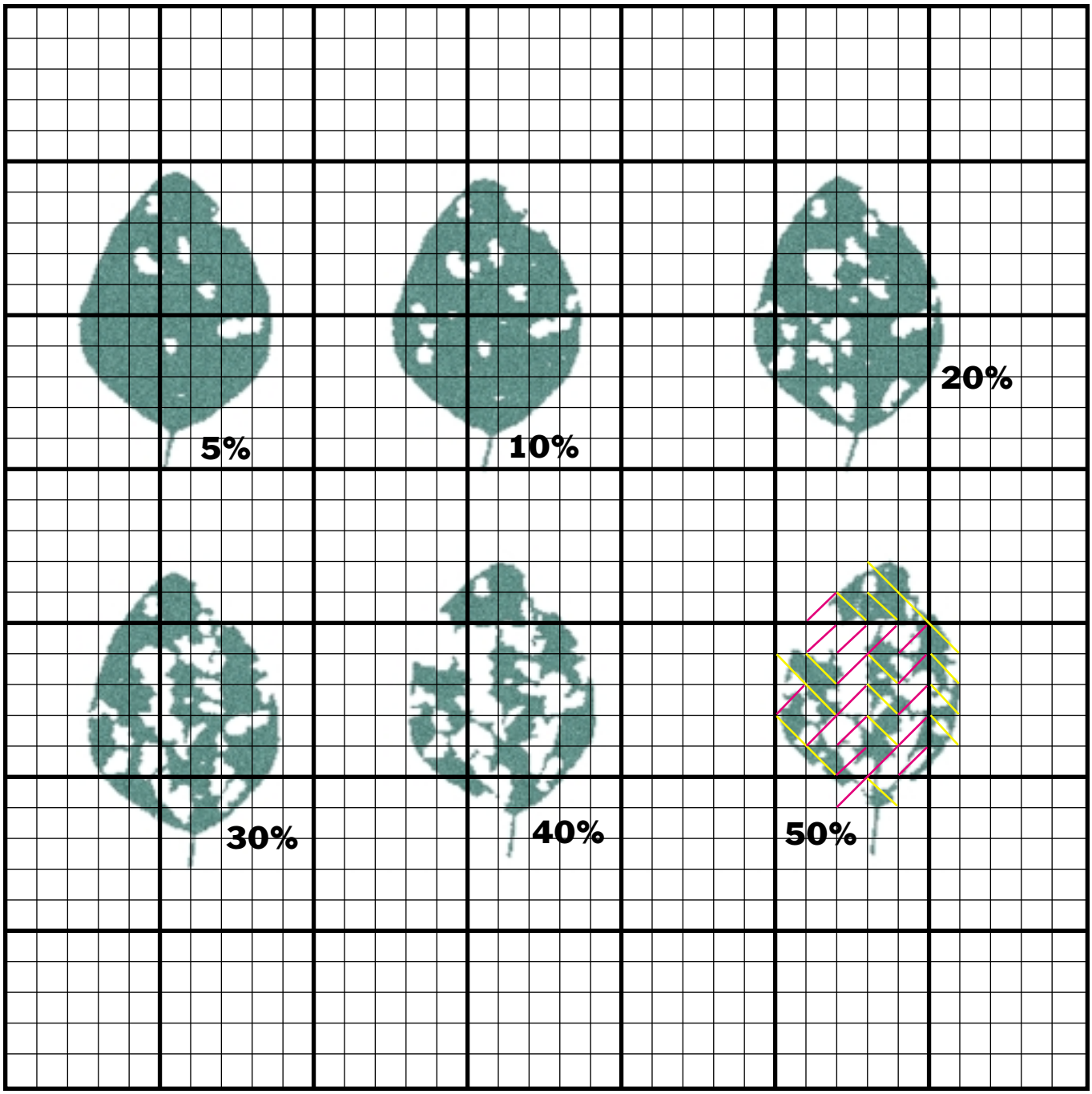
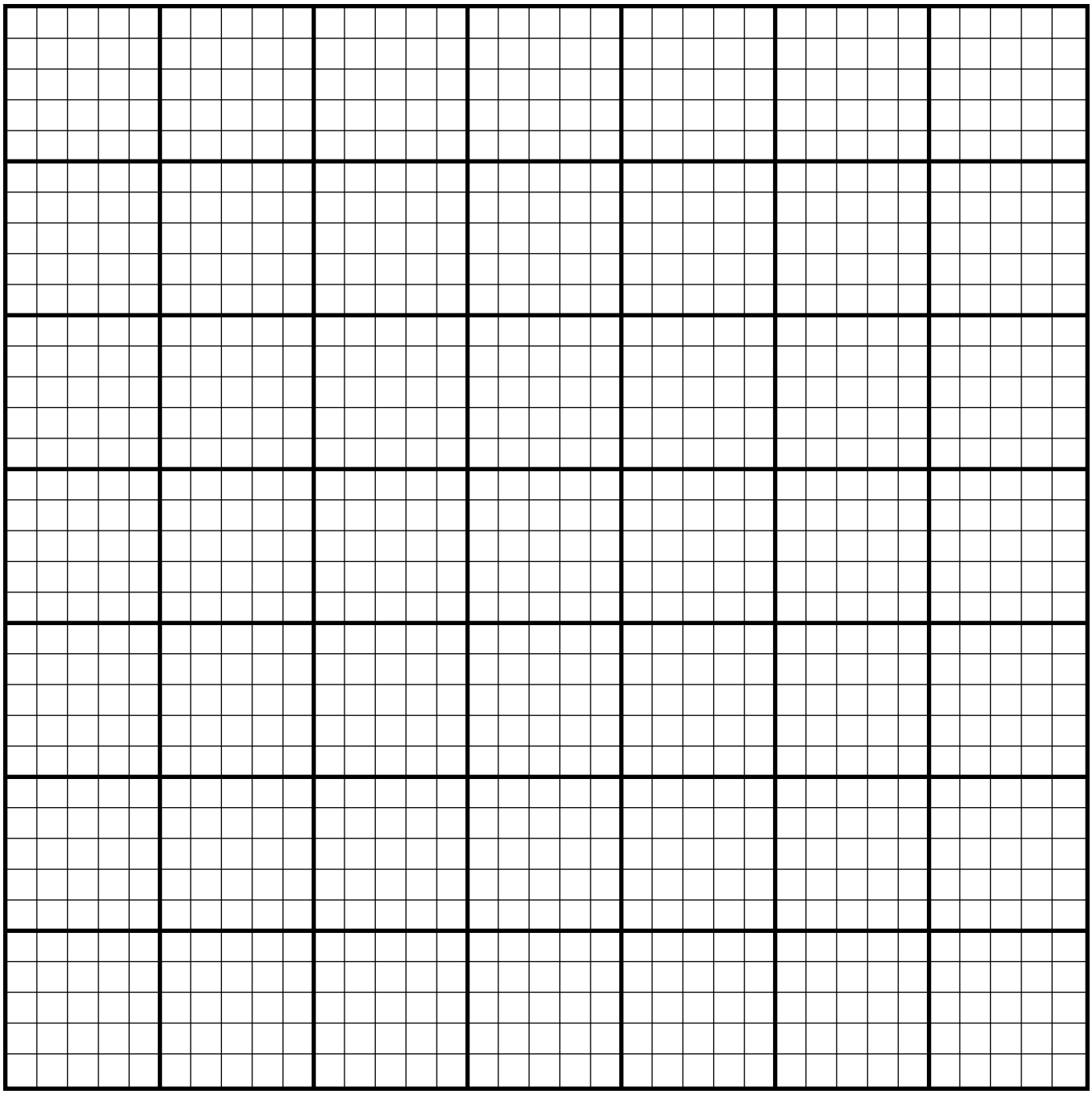


Figure 2. Sample leaf defoliation levels of early-vegetative stage soybean caused by bean leaf beetles. Percent defoliation below each leaf was determined using an electronic leaf area meter (Iowa State University). Accurate estimation also can be obtained by counting each cell occupied (50% or more) by the missing and total areas of the leaf sample as illustrated above. Refer to "Estimating percent defoliation" for procedures in measuring defoliation using the graphing paper technique (—cell at least 50% occupied by a normal leaf tissue, —cell at least 50% occupied by a missing leaf tissue).

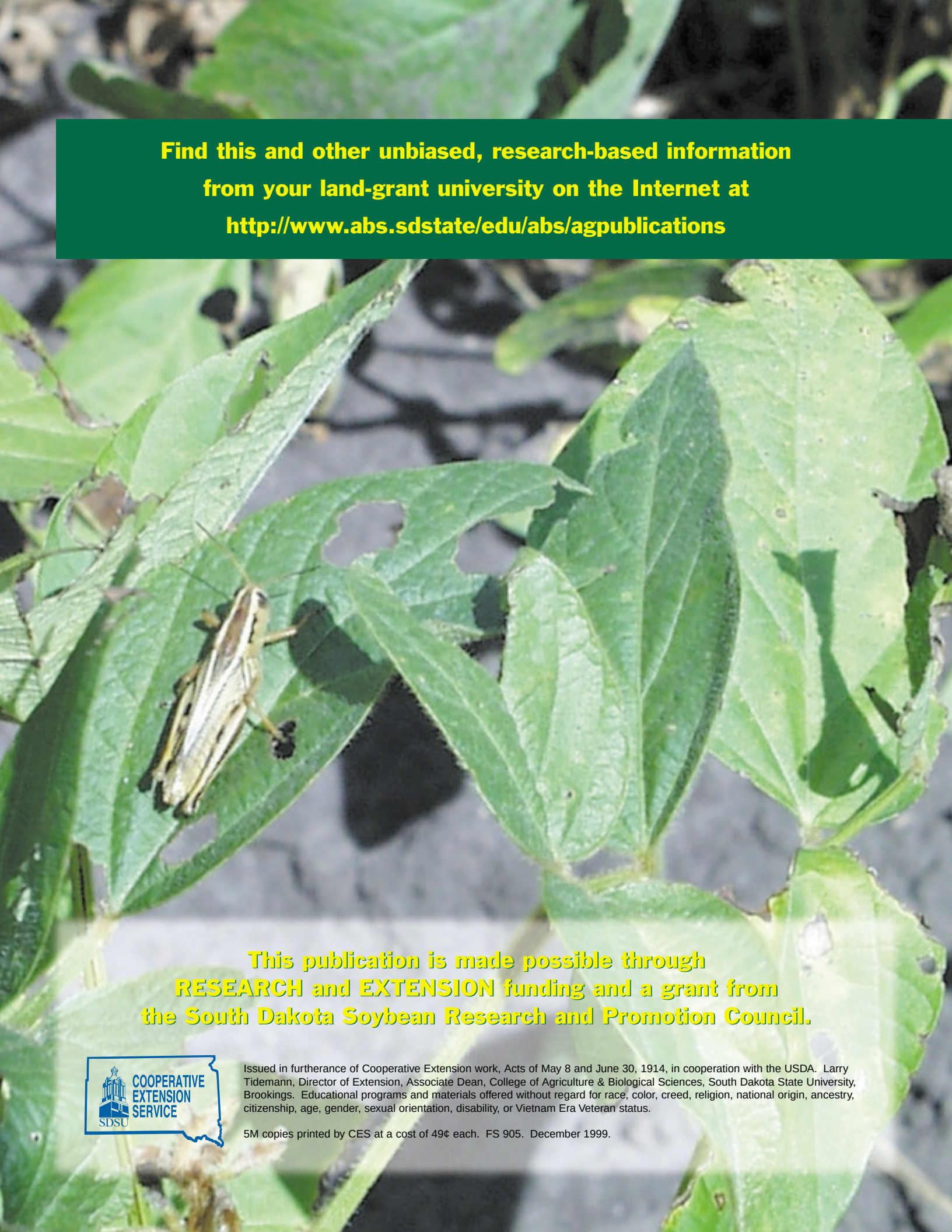


Estimating percent defoliation of a soybean leaf

- Count the total number of square cells occupied by the leaf area (as if the leaf were undamaged). Count only cells that are at least 50% covered by the leaf area.
- Count the number of cells occupied by the missing leaf tissues. Count only cells that are at least 50% empty.
- Calculate percent defoliation as: $\%\text{defoliation} = \frac{\text{no. missing cells} \times 100}{\text{total no. cells occupied}}$

COOPERATIVE EXTENSION SERVICE SDSU

For assistance in applying this information to your cropping system, contact your county Extension educator or Mike Catangui, Extension entomologist, SDSU Plant Science Department.



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