United States
Department of
Agriculture

Animal and
Plant Health
Inspection
Service

Plant Protection
and Quarantine

Cooperating State
Departments of
Agriculture

December 1985

ACTION PLAN

SENN PEST Complex
Eurygaster integriceps Puton Sensu lato

This PPQ Action Plan or New Pest Response Guideline has not been updated since its publication date. The actions or guidelines recommended may not be appropriate now, new survey tools may be available, and chemical pesticides named may no longer be registered. This documents is posted until updated versions can be drafted and as such are only guidelines that represent the state of knowledge at the time they were written. Please consult PPQ and/or your State Plant Regulatory Official prior to implementing any recommendations listed herein.

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AUTHORIZATION

This Action Plan provides guidelines and actions for the eradication of a senn pest infestation. This Action Plan supplements information contained in the Plant Protection and Quarantine (PPQ) Treatment, Emergency Programs, and Administrative Procedures Manuals.

It is to be used in conjunction with other manuals when conducting emergency program activities. The information and instructions contained in this Action Plan were developed with and approved by representatives of cooperating States, the U.S. Department of Agriculture's Agricultural Research and Cooperative State Research Services, and affected industry.

All program technology and methodology employed are determined through discussion, consultation, or agreement with the cooperating State officials.

NOTICE

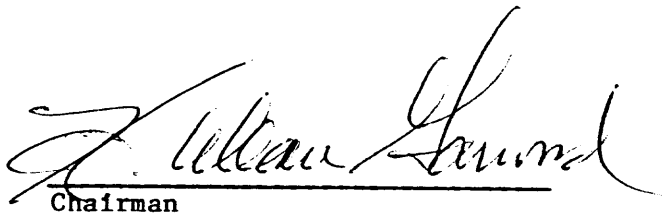
Recommendations in this Action Plan, which involve the use of pesticides, concern products which are registered or exempted under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended. Precautions on the pesticide label and all instructions in this Action Plan must be carefully followed.

Federal and/or State personnel may not make any warranty or representation, expressed or implied, concerning the use of these products and shall not be responsible for any loss, damage, or injury sustained as a result of the use of any product as specified in this Action Plan.

The use of trade names in this Action Plan does not imply an endorsement of those products or of the manufacturers thereof by Federal-State pest control programs. Equivalent formulations under different trade names are acceptable.

Deputy Administrator
Plant Protection and Quarantine

Date



Chairman
National Plant Board

Date

I. GENERAL INFORMATION

A. Action Statement

The information contained in this document is intended for use when a senn pest infestation is known to exist. This Action Plan is to be used for guidance in implementing eradication procedures and in preventing spread to other locations. It provides technical and general information needed to implement any phase of a senn pest eradication program. Specific program action is to be based on information available at that time.

B. Background Information

The senn pest is native to the Middle East. This bug occurs all the way from Yugoslavia in the west to Pakistan in the east and throughout the southeastern part of the Soviet Union to the Arabian Sea. It is recorded from cereals and grasses throughout the area. Due to stringent quarantine requirements, the senn pest has not been intercepted in this country for many years. It is a devastating threat to cereal crops such as wheat, rye, barley, sorghum, and oats. Injury results from damage to the growing points of hosts, which prevents tillering, or to the kernels, which prevents them from filling out. The plant is literally drained of nourishment through the bug's intake of its sap, leaving a dry withered husk with empty kernels.

Development from egg to adult at an optimum temperature of 75.2 to 82.4 ^{o}F (24 to 28 ^{o}C) and relative humidity of 60 to 65 percent takes less than 2 months (approximately 34 to 52 days).

The adult does not become sexually mature in the first season. During intensive feeding it stores fat reserves to survive the winter. If dry weather occurs, the adult may migrate to higher, cooler areas or else to local forested areas to aestivate the remainder of the summer until fall. With the arrival of winter, the bugs may undertake another generally shorter migratory flight to warmer altitudes, feed some more, and subsequently hibernate under litter and other protection, especially as provided for by certain bushy shrubs and trees like sagebrush and pines. In the spring the adult returns to the fields. The male may be sexually mature, but the female feeds first before completing sexual development. One generation requires 1 year under these conditions. It is likely that the species of this complex can exist in any part of the United States.

C. Life Cycle Application

Insect development and activity are temperature dependent. Egg and nymphal development is influenced by air temperatures. Adult and nymphal movement and migratory ability are influenced by air temperatures and availability of food and shelter. For senn pest, the onset of spring, possible summer migration, fall migration, the hatching of eggs, and the appearance of the first nymphal stages are critical points. Spring migration begins when air temperatures reach 64.4 ^{o}F (18 ^{o}C) in the overwintering areas.

The hatching of eggs can be determined in advance by the retention of samples under local conditions in the laboratory and observing the formation of head and eyes. Summer migrations should be anticipated under hot, dry conditions; fall migrations must be expected with crop harvest and the onset of cooler weather.

Program actions are guided in part by the insect life cycle data. Eradication treatments, length of survey activities, and regulatory functions are affected primarily by the length of time needed to complete each phase of the life cycle. Temperature data are available from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, private, State, university, or industry sources, or can be generated by strategically placing thermometers to measure air temperatures.

II. SURVEY PROCEDURES

A. Delimiting Survey

1. When one or more senn pests are collected in an area, a delimiting survey will be implemented immediately to determine the population distribution.

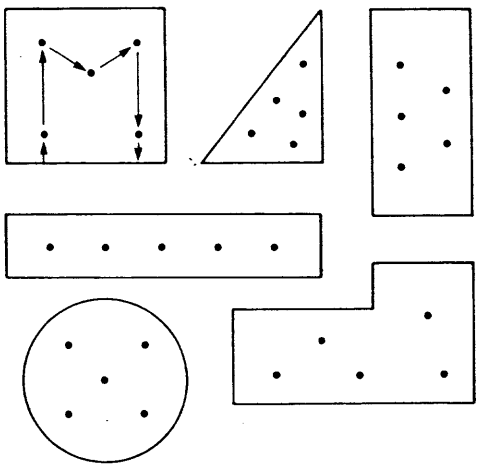
Using the site of the detection as the focal point (epicenter), locate suitable host fields in each kilometer (km) of a core area of 4 square kilometers (km^2) (1.54 square miles (mi^2)). Up to 100 hectares (ha) (approximately 250 acres (a)) of available host are to be surveyed in the core. This will include 20 ha (50 a) in each km^2 and around the epicenter or the nearest feasible host field. In lieu of suitable host fields in a given km, stands of wild grasses or other hosts may be surveyed. Each field will be sampled at five or more locations. The survey is to be repeated weekly for at least three senn pest generations.

Host fields with dry leaf, withered central clusters, white ear, or punctured kernels receive the first priority. Otherwise, sample fields should be equally spaced, with a bias toward the center of each find.

Sampling should follow a similar pattern for each field surveyed. Very large fields may need to be divided into smaller units of a maximum of 4 ha (10 a). Each unit is counted as a separate field. Not all such units should be sampled at the same time in order to keep spacing of sample fields roughly equal (except as given above).

Before sampling, enter the field at least 23 meters (m) (75 feet (ft)) and take samples at a minimum of five different sites in the field. Move from site to site following a predetermined pattern such as given below.

Field Survey Pattern



a. Sweep Net

At each location use a sweep net to sweep hosts, including any interspersed wild grasses, on a diagonal transect for 20 m (approximately 22 yards (yd)). Direct sweeps to cover the upper part of the hosts, especially plants with visible evidence of dry leaf, withered, yellowed central clusters, and white ear injury. Wild grasses adjacent to the field may also be swept. During hot, dry periods, sweeping is advisable in the early morning and late afternoon. Sweeping is limited to spring and summer and terminated when the adults leave the fields for aestivation or hibernation.

b. Egg Survey

At each location, examine the underside of host leaves for egg batches. Collect the eggs for identification and/or for control purposes. They may be collected at any time during survey operations, but emphasis shall be placed on a specific search during each return from a sweep and between field locations. Limit egg surveys to spring and stop when egg batches disappear and only second instar nymphs or older stages are seen.

c. Host Damage

At each location the condition of the host should be carefully observed. Signs of senn pest are dry leaf, punctured vein, withered, yellowed central cluster (punctured stems), white ear injury (whitehead), and punctured kernels. Plants showing such injuries should be carefully checked within 1-m (3-ft) radius area. This operation is to be carried out with sweeping activities from spring through summer.

d. Congregation Areas

(1) At each location, cracks in the soil, large flat stones, etc., may be checked for bugs if the weather is very hot and dry. If a given host heads and is left untended or to fallow, the bugs will remain in the field, provided green weeds are available. If the crop is harvested, the bugs may leave unless substantial litter and green weeds are left. In either case the bugs will subsist on dry kernels plus moisture from the weeds. They will congregate under any heaped litter and must be looked for there.

(2) If hot and dry conditions persist, the bugs will aestivate. Nearby locations will be in adjacent woods under shelter plants. Select such locations for survey in the same

manner as for host fields (host field surveys are discontinued under such conditions). The survey may be carried out by transecting a selected location and pulling up shelter bushes such as sagebrush or clearing away pine needle or leaf litter under shelter trees. Adults will be aestivating under the litter.

(3) With the advent of cold weather, the bugs will look for hibernating areas. Sometimes these areas will be the same as the host fields or aestivating areas; in other cases they go elsewhere. In any case, at least a small number will stay if suitable hosts are available in a given area. During fall and winter, both host fields and adjacent woods may be checked for hibernating adults as for aestivation. Also, check underneath clumps of dead vegetation and such litter, digging a sample of soil up to 12 centimeters (cm) (4.7 inches (in)) deep in likely places.

(4) Shelter plants are plants that generally shed enough litter or whose branches form a cushion at about ground level, which protects the aestivating or hibernating adult bug.

In winter under very cold conditions, an additional cover of snow is needed. Based on the types of plants providing such shelter in Europe and Asia, the litter under junipers, oaks, pines, and any similar trees providng ample fallen foliage is suspect and should be checked. Low-lying bushes such as locoweed, asphodel, daphnes, or sagebrush should also be checked for the same reason.

e. Female Lure Traps

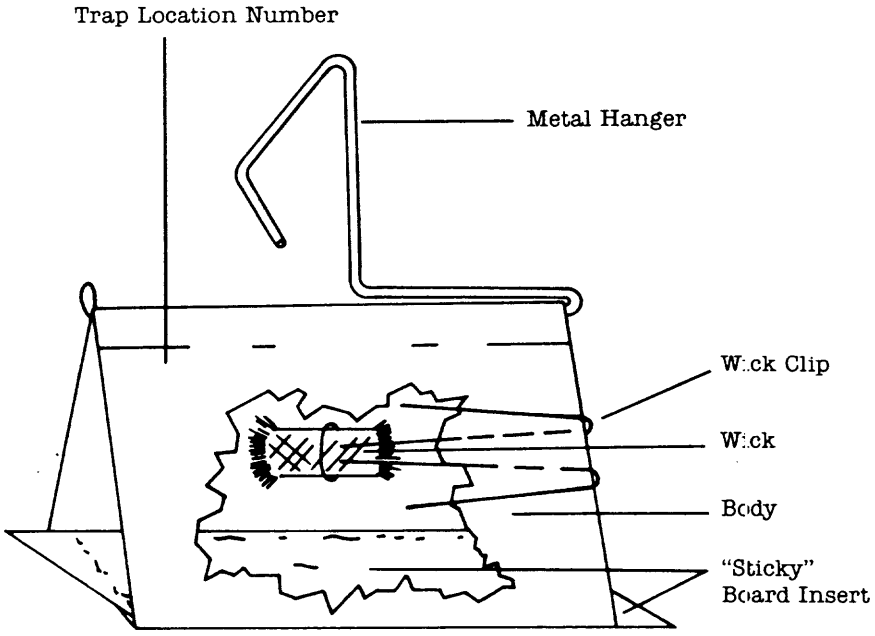
A Jackson trap, normally used for fruit flies, is employed. A Richmond dental wick 19-millimeter (mm) (3/4-in) in diameter and 38.2-mm (1 1/2-in) long will be installed in the trap. The wick will be baited with a 1:1 mixture of vanillin and ethyl acrylate in an equal amount of 20 percent ethanol. Enough lure (approximately 6 milliliter (mL)) (0.20 ounces (oz)) will be added to saturate the wick without dripping. At subsequent servicings enough lure will be added to saturate the wick, again without dripping.

Traps will be placed in host fields just below the height of the host on 2- by 2-in (5- x 5-cm) stakes or wooden posts. Traps will be stapled or otherwise attached to a stake to allow bugs to walk into the trap.

Traps will be deployed at a rate of 32 per km^2 (83 per mi^2) in the core area. Trapping will be carried out for roughly 1 to

2 months, during spring migration or estimated spring migration, and until breeding in a given area is estimated tc be over (generally late spring).

Jackson Trap



Trapping will be a separate activity from other survey activities and carried out when regular survey activities indicate a low and hard-to-detect level of population or to help assure that senn pest no longer occurs in a given area.

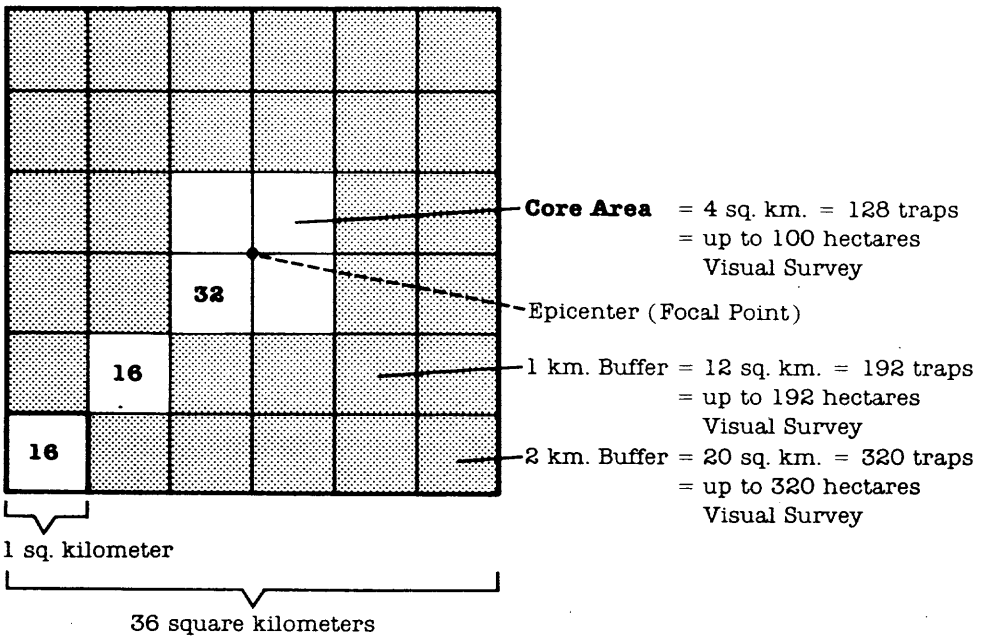
2. The extent of survey operations is given as follows:

a. If only one adult male or nongravid female is detected, the delimiting survey is limited to the 4-km^2 (1.54-mi^2) core area.

b. If a gravid female, a nymph, or two or more adults are found within a 4-km^2 (1.54-mi^2) area, the delimiting survey will be conducted over 16 km^2 (about 6 mi^2). Traps will be deployed in the core area at a rate of 32 per km^2 (83 per mi^2) and in the buffer area at 16 per km^2 (41 per mi^2).

c. If six or more detections are made in an area involving 16 km^2 (6 mi^2) or more, the delimiting survey will be conducted over a 36-km^2 (14-mi^2) area around each find. Traps will be deployed in the core and 1- and 2-km buffer areas as in 2a and b above.

Survey Per Square Kilometer



B.	Monitoring/ Evaluation Survey	A monitoring/evaluation survey will be conducted in that area where eradication treatments are applied. The sweep, visual, and trap systems are all maintained at the delimiting rate.
C.	Host Collection and Holding	Collected parts (shoots, stems, ears with nymphs, and leaves with eggs) will be held at temperatures and humidity that will permit insect development to the point where a positive determination can be made. The facility where the hosts are held must be secure to prevent any inadvertent release of bugs. Security measures must be equal to those established for a quarantine insect-rearing facility. See Animal and Plant Health Inspection Service 81-61 for detailed information.
D.	Detection Survey	The area beyond the last buffer zone will be surveyed in randomly selected 4-km^2 (1.54-mi^2) blocks up to 80 km (50 miles (mi)) away. There will be a maximum of 8 blocks with suitable host, aestivating, or hibernating areas depending on time of year and climate in area of finds. Bias will be given to prevailing winds in selecting blocks. Where hot, dry summers prevail, consideration must be given to locating blocks in cool mountainous areas up to 80 km (50 mi) away. Survey and trapping in each block will be at the delimiting rate for the core area. Publicity including drawings and descriptions will be utilized to enlist public assistance in locating infested areas.
E.	Orientation of Survey Personnel	New personnel will be trained on the job by experienced personnel. It will be necessary to have 3 working days to teach the many facets of the sunn pest survey.
F.	Survey Records	Records noting the areas surveyed, sites trapped, dates, locations, and hosts on which detections were made will be maintained (see Addendum F).

III. REGULATORY PROCEDURES

A. Instructions to Officers

Regulatory actions will be required until the pest is eradicated. Officers must follow instructions for regulatory treatments or other procedures when authorizing the movement of regulated articles. Understanding the instructions and procedures will serve as a basis for explaining such procedures to persons interested in moving articles affected by the quarantine and regulations. Only authorized treatment procedures may be used.

General instructions that are to be followed in regulatory treatments are found in the PPO Treatment Manual.

Officers may aid shippers in selecting the authorized treatment or procedure that is most practical for the shippers. They should advise the shipper to apply selected treatments to small quantities of material prior to treating larger quantities to determine the reaction or effects of the treatment procedure. When treating commodities which are particularly sensitive to the treatments selected, treat more of the commodity than is needed to allow for possible losses.

B. Regulated Articles

1. Any part of the following:

Common Name	Scientific Name
Barley	Hordeum vulgare
Clover	Trifolium spp.
Common licorice	Glycyrrhiza glabra
Corn	Zea mays
Cotton thistle	Onopordum spp.
Flax	Linum spp.
Germanders	Teucrium spp.
Goatgrass	Aegilops spp.
Knapweeds	Centaurea spp.
Oats	Avena sativa
Rye	Secale cereale
Sorghum	Sorghum bicolor
Spurge	Euphorbia spp.
Sunn hemp	Crotalaria juncea
St. John's wort	Hypericum spp.
Sunflower	Helianthus spp.
Thistles	Carduus spp.
Vetch	Vicia spp.
Wheat	Triticum aestivum
White mustard	Sinapsis alba
All Wild grasses	Poaceae spp.

2. Soil and sod from the infested area. Straw, plant leaves, and other vegetative parts used as packing material.

3. Any other product, article, or means of conveyance of any character whatsoever when it is determined by an inspector that they present a hazard of spread of senn pest and the person in possession thereof has been so notified.

C. Quarantine Actions

When detections are made, the following steps should be implemented in sequence:

1. With the detection site considered the epicenter, all growers and establishments that grow, handle, move, or process regulated articles, including soil and sod removal/supply firms, within a minimum of 3 linear (lin) km (approximately 1.86 mi) will be issued Emergency Action Notifications (PPQ Form 523) requiring treatment or other approved handling procedures. Emergency Action Notifications and/or comparable State notifications are issued by field personnel to the property owners or managers of all establishments who grow, handle, move, or process articles capable of spreading the senn pest. A notification will be issued pending authoritative confirmation and/or further instruction from the Deputy Administrator.

2. If necessary, the Deputy Administrator will issue a letter directing PPQ field offices to initiate specific emergency action under the Federal Plant Pest Act (7 U.S.C. 150dd) until interim regulations announcing emergency action can be published in the Federal Register.

The Federal Plant Pest Act of 1957 provides for authority for emergency regulatory action. This provision is for interstate regulatory action only; intrastate regulatory action is provided under State authority. However, if the Secretary of Agriculture determines that an extraordinary emergency exists and that the measures taken by the State are inadequate, the U.S. Department of Agriculture (USDA) can take intrastate regulatory action provided that the Governor of the State has been consulted and a notice has been published in the Federal Register.

The Organic Act of 1944, as amended, provides the Federal Government, either independently or in cooperation with States or political subdivisions thereof, farmers' associations and similar organizations, and individuals, the authority to carry out operations or measures to detect, eradicate, suppress, control, or to prevent or retard the spread of plant pests. This Act does not provide for trespassing on private property but relies upon

State authority and willingness to use State right-of-entry authority.

All program technology and methodology employed are determined through discussion, consultation, or agreement with the cooperating State officials.

3. The Deputy Administrator, through the National Regional Directors, will notify State cooperators of the senn pest detection, actions taken, and actions contemplated.

A narrative description of the regulated area with support documents will be developed by the USDA and cooperators and provided to the Regulatory Services Staff, National Program Planning Staff (NPPS). The regulated area will also be defined by the Universal Transverse Mecator Grid Marking System for use by the Project Manager.

4. The Animal and Plant Health Inspection Service (APHIS) Regulatory Coordination Staff will publish interim regulations, which are effective on publication, under the Federal Plant Pest Act in the Federal Register to announce an emergency action. Written comments will be solicited (for approximately 60 days) on the rule from the public. If a quarantine is warranted after consideration of submitted comments, a final rule under the Plant Quarantine Act will be published in the Federal Register.

D. Regulated Establishments Inspection

Efforts to detect the pest within the regulated area will be made at all establishments where regulated articles are grown, handled, moved, or processed. Establishments that might be involved are airports, landfill sites, processing plants, bakeries, sod and soil firms, farmers', produce, and flea markets, nurseries, flower shops, and any other establishment that handles regulated articles. Two female lure traps per establishment will be set and serviced weekly. Traps will be placed where bugs can walk into the trap by traveling upward, no more than 3 ft (0.9 m) from the ground. They may be stapled to a wall or other object.

E. Use of Authorized Chemicals

The PPQ Treatment Manual and this Action Plan contain the authorized chemicals, methods and rates of application, and any special application instructions. Concurrence by the PPQ Survey and Emergency Response Staff (SERS) is necessary for the use of any chemical or procedure for regulatory purposes.

F. Approved Regulatory Treatments

1. Dry Heat. The use of high temperatures as a treatment alone.

2. Fumigation. The application of an approved fumigant as a treatment alone or in conjunction with vacuum procedures.

3. Sanitation. The removal and destruction of leaves, stems, stalks, and other host material from small lots or when material is limited.

4. Steam Sterilization. The use of live steam as a treatment alone.

5. Soil Treatment. An approved insecticide applied to the soil of host plants.

6. Ground Spray. An approved insecticide applied to the above-ground parts of nursery stock.

G. Principal Activities

The following identifies principal activities necessary for conducting a regulatory program to prevent the spread of senn pest. The extent of regulatory activity required depends on the degree of infestation. For example, safeguarding soil and sod firms throughout the entire regulated area that are engaged in only local retail activity may not be necessary when the regulations that are imposed are based on a limited and light infestation. Mandatory checks of passenger baggage at airports and the judicious use of road patrols and roadblocks may be necessary where general or heavy infestations occur.

1. Advising regulated industry of required treatment procedures.

2. Supervising, monitoring, and certifying commodity treatments of commercial lots of regulated articles.

3. Contact visits with:

   a. Security and airline personnel;
   b. Soil and sod firms;
   c. Flower stands and nurseries;
   d. Local growers, packers, and processing plants;
   e. Farmers', produce, and flea markets;
   f. Commercial haulers of regulated articles; and
   g. Public transportation.

4. Visiting bakeries and other processing establishments.

5. Monitoring the movement of material to landfills to ensure adequate disposal of regulated article refuse.

6. Monitoring the movement of regulated articles through major airports and other transportation centers.

7. Movement of host material along major highways and across quarantine boundaries.

H. Orientation of Regulatory Personnel

Only trained or experienced pesonnel will be used initially. Replacement personnel will be trained by the individual being replaced. A training period of 3 working days is necessary for the orderly transfer of these functions.

I. Regulatory Records

Records will be maintained as necessary to carry out an effective, efficient, and responsible regulatory program (see Addendum F).

IV. ERADICATION PROCEDURES

The SERS, in consultation with methods and research agencies, outlines treatments to be used and must be notified of all treatment plans. If treatments selected or proposed are not in conformance with current pesticide labels, an emergency exemption may be provided under Section 18 of the FIFRA, as amended. For further instructions, see Emergency Programs Manual, section V, B.

Eradication of a senn pest infestation is essential. Local conditions will determine the most acceptable procedure to achieve eradication.

A. Recommended Pesticides

1. Baytex
2. Diazinon
3. DDVP
4. Sumithion
5. Trichlorfon

Other pesticides that should be considered include Counter® and Lorsban®.

B. Approved Eradication Treatments

1. Ground Spray

Ground application of insecticide will be initiated immediately if the bug is active. All host plants that provide for reproduction of the senn pest on the infested property, adjacent property, and within 200 m (216 yd) of the known infestation will be sprayed if host material is scattered or infestation is light. Spraying may be extended to cover adjacent properties if they have substantial host material. Ground application in large infestations will be applied to host material to a minimum of 2 lin km (1.24 mi) beyond any known infestation. Ground spraying may be discontinued after an estimated two generations (2 years) of negative survey or after the initiation of aerial treatment. Yearly ground applications will consist of two or more treatments for active adults and older nymphs (fourth and fifth) and one treatment only for young nymphs (first to third).

The following pesticides may not be registered for this use on a given crop. Any application inconsistent with product labeling must have prior approval.

a. Metric Measurement

Trichlorfon (Dylox®)--1.5 to 2.2 liters (L) (1.12 to 1.7 kilograms (kg) actual ingredient (ai)) of 80 percent trichlorfon in up to 935 L of water per ha. Apply as a spray when detections are made in host fields of overwintered adults, of fourth to fifth nymphal stages, of the new generation of adults, or of estimated such

appearance. Two applications per year should cover the normal active period; but if climatic conditions permit activity of the new adult generation 15 days or more beyond the second application, then applications may continue approximately 15 days apart until the new adults enter the aestivation or hibernation phase.

Sumithion (Sumithion 8E)--154.1 mL (140.1 grams (g) ai) in up to 935 L of water per ha. Apply as a spray when eggs and nymphal stages are present. Only one application per season.

b. U.S. Measurement

Trichlorfon (Dylox®)--20 to 30 oz (16 to 24 avoirdupois ounces (avdp oz) ai) of 80 percent trichlorfon in up to 100 gallons (gal) of water per a depending on type of equipment. Apply as a spray when detections are made in host fields of overwintered adults, of fourth to fifth nymphal stages, of the new generation of adults, or of estimated such appearance. Two applications per year will normally cover the normal active period; but if climatic conditions permit activity of the new adult generation 15 days or more beyond the second application, then applications may continue approximately 15 days apart until the new adults enter the aestivation or hibernation phase.

Sumithion (Sumithion 8E)--2.1 oz (2 avdp oz ai) in up to 100 gal of water per a depending on the type of equipment. Apply as a spray when eggs and nymphal stages are present. Only one application per season.

2. Aerial Spray

Aerial application of insecticide will be initiated immediately if the bug is active. Aerial spray will be applied when and where ground treatment is not practical. Applications will be made at the prescribed intervals over a minimum period equal to two life cycles (2 years) after the last find and during the active or estimated active period for adults and nymphs. Applications will consist of two or more treatments for active adults and older nymphs (fourth to fifth) and one treatment only for young nymphs (first to third). The area to be sprayed will extend a minimum of 2 lin km (1.24 mi) beyond any known infestation.

The following pesticides may not be registered for this use on a given crop. Any application inconsistent with product labeling must have prior approval.

a. Metric Measurement

Trichlorfon (Dylox®)--1.5 to 2.2 L (1.12 to 1.7 kg ai) of 80 percent trichlorfon in a minimum of 7.57 L of water per ha depending on type of equipment and crop/host being sprayed. Apply as a spray when detections are made in host fields of overwintered adults, of fourth to fifth nymphal stages, of the new generation of adults, or of estimated such appearance. Two applications per year will normally cover the active period, but if climatic conditions permit activity of the new adult generation 15 days or more beyond the second application, then applications may continue approximately 15 days apart until the new adults enter the aestivation or hibernation phase.

b. U.S. Measurement

Trichlorfon (Dylox®)--20 to 30 oz (16 to 24 avdp oz ai) of 80 percent trichlorfon in a minimum of 2 gal of water per a, depending on type of equipment and crop/host being sprayed. Apply as a spray when detections are made in host fields of overwintered adults, of fourth to fifth nymphal stages, of the new generation of adults, or of estimated such appearance. Two applications per year will normally cover the active period, but if climatic conditions permit activity of the new adult generation 15 days or more beyond the second application, then applications may continue approximately 15 days apart until the new adults enter the aestivation or hibernation phase.

3. Soil Treatment

Sites with confirmed infestations of senn pest will have approved soil treatments applied to kill resting, aestivating, and hibernating bugs. During the active phase of the bug's life cycle, such soil treatments will be applied to the surface of the soil in and near host fields with confirmed finds. At other times, soil treatments will be applied to the above host fields, to nearby forest areas where likely conditions occur for aestivating or hibernating bugs, and to any aestivating or overwintering areas as may be found through survey efforts.

Treatment will be applied at the prescribed intervals. The following pesticides may not be registered for this use. Any application inconsistent with product labeling must have prior approval.

a. Metric Measurement

Diazinon (Diazinon AG-4)--108.8 mL (52.2 g ai) of 48 percent Diazinon in enough water to soak 2.5 to 5 cm of soil over 92.9 square meters (m^2) to kill resting, aestivating, or hibernating bugs. Apply treatments at 14- to 16-day intervals during the active season to the soil of all hosts on properties where bugs have been found and the environs within 200 m. A final application is made each year after departure or estimated departure of the bug to kill any that remain. This may also be carried out in conjunction with plowing of stubble after harvest. An initial application will be laid down in the following spring at the beginning of migration or estimated migration to kill arriving bugs. Forest, aestivating, and hibernating areas will receive one treatment in summer to fall, at time of arrival or estimated arrival, and again just before departure or estimated departure of bugs. Work application under litter and shelter plants when practicable.

DDVP (Vaponite 2)--19.7 mL (4.67 g ai) of 24.5 percent DDVP in 0.95 L of water per 92.9 m^2 to kill resting, aestivating, or hibernating bugs. Applications are restricted to forest, aestivating, and hibernating areas as given above.

b. U.S. Measurement

Diazinon (Diazinon AG-4)--3.68 oz (1.84 avdp oz ai) of 48 percent Diazinon in enough water to soak 1 to 2 in of soil over 1,000 square feet (ft^2) to kill resting, aestivating, or hibernating bugs. Apply treatments at 14- to 16-day intervals during the active season to the soil of all hosts on properties where bugs have been found and the environs within 656 ft. A final application is made each year after departure or estimated departure of the bug to kill any that remain. This may also be carried out in conjunction with plowing of stubble after harvest. An initial application will be laid down in the following spring at the beginning of migration or estimated migration to kill arriving bugs. Forest, aestivating, and hibernating areas will receive one treatment in summer to fall, at time of arrival or estimated arrival, and again just before departure or estimated departure of bugs. Work application under litter and shelter plants when practicable.

DDVP (Vaponite 2)--0.66 oz (0.165 avdp oz ai) of 24.5 percent DDVP in 1 quart (qt) of water per 1,000 ft^2 to kill resting, aestivating, or hibernating bugs. Applications are restricted to forest, aestivating, and hibernating areas as given above.

Weather conditions may dictate changes in spray schedule. After an estimated two generations of negative trapping and survey, spray operations may be discontinued.

The decision to apply insecticides will be based on the best weather information available. In the event rain washes an application from the foliage, plans will be implemented to re-treat the area.

Re-treatment should not be considered if weather reports indicate 50 percent or greater chance of precipitation in the 48-hour period following washoff.

The objectives are to eradicate the pest and minimize environmental contamination. Any treatment or re-treatment recommendation must consider these objectives.

4. Sanitation

Sanitation will consist of the following measures, to be applied depending on circumstances and equipment available.

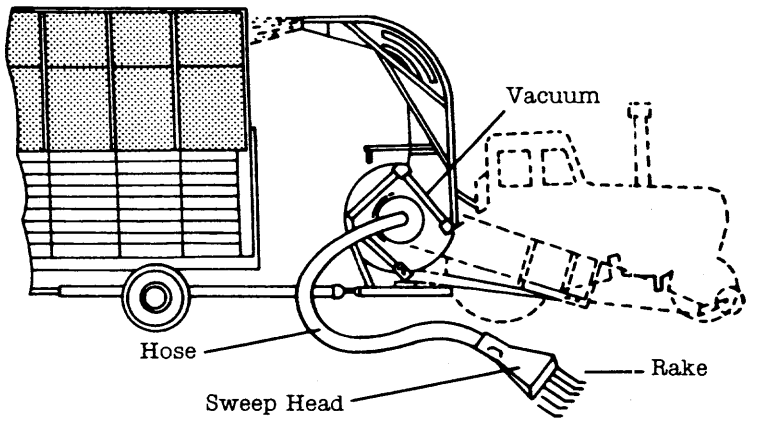
a. Clearing: Sanitation in nurseries, farms, gardens, and other establishments where hosts are present will be carried out within the core and buffer areas. Clearing shall consist of the collection and destruction of all host parts, particularly weeds, but also including any piles of host under which bugs could hide.

b. Burning of Debris: When host material is collected, it may be piled into heaps and burned. The residue can then be disked under or otherwise buried in an approved landfill.

c. Litter: Litter in hibernation, forest, or aestivation areas may be destroyed if the infested area is limited in extent. Burning or slashing of shelter plants should only be considered under limited circumstances due to fire and erosion hazards.

d. Collection: To some extent, where practical, bugs may be collected by mechanical means if populations are very heavy. Hand vacuum collectors, sweep nets, and truck-mounted vacuum rigs may be used in the field. In woods, aestivation, or hibernation areas where bugs can pile up in great numbers under litter or shelter plants, vacuum devices or spade and bucket are the primary tools.

Truck-mounted Vacuum Rig



Vacuum Rig on Tractor. Chimney sweep vacuum rigs may also be modified for this use.

C. Eradication/ Control Method Selection

The following parameters or criteria will determine the minimum treatments to be used in achieving eradication. Expanded or additional treatment actions can be applied if mutually agreed upon by cooperating agencies.

Eradication measures will continue for at least two generations, and trapping will continue for at least three generations following the last detection.

1. If one adult male or one unmated adult female is detected, no eradication treatments will be initiated.

2. When one to five mated females, one to five nymphs, or two to five males/unmated females are detected in an urban/residential area of less than 16 km^2 (6 mi^2), sanitation as specified and throughout the core and buffer areas plus soil treatment to 200 m (216 yd) beyond any known infestation will be employed. Similar detections in a commercial production area will require treatment as above, plus ground or aerial sprays as applicable.

3. When more than six of any stage are detected in an area greater than 16 km^2 (6 mi^2), all the above measures with ground spray only will be employed in urban/residential areas and with the addition of both ground or aerial sprays, as applicable, in commercial production areas.

The minimum treatments prescribed are predicated on an adequate survey.

D. Orientation of Eradication/Control Personnel

Only trained and experienced personnel will be utilized initially. Replacement personnel will be trained by the individual being replaced. A period of 3 working days is necessary for the orderly transfer of these functions.

E. Eradication/Control Records

Records noting the location of detection, dates, number and type of treatments, and materials and formulations used will be maintained for all areas treated (see Addendum F).

F. Monitoring

An effective monitoring program will be implemented to aid in the evaluation of program efforts and environmental impact. The application and use of insecticides and other controlled substances will be assessed through the use of appropriate program monitoring criteria. The evaluation must effectively address Agency, cooperator, and public concerns.

The monitoring program will include at least the following elements:

1. Determining efficacy of the insecticide against the target pest.

2. Evaluating dye cards to monitor aerial application.

    a. Droplet size information;
    b. Droplet distribution information;
    c. Identification of wind drift components;
    d. Verification of spray block boundaries; and
    e. Identification of skips.

3. Sampling to evaluate effect on environmental components.

    a. Water sampling to detect insecticide levels through direct application, leaching, and runoff;
    b. Soil sampling to determine insecticide levels and residues;
    c. Foliage sampling to identify residues;
    d. Biological organism sampling during applications and post-treatments to determine impact of insecticides; and
    e. Air sampling to determine presence of pesticides in respirable air.

The monitoring program is to be a combined effort between the State in which the emergency program is being conducted and PPQ. If specific plans need to be developed for monitoring activities, the SERS will request assistance and guidelines from other NPPS staffs.

V. CONTACTS

When a senn pest eradication program has been implemented, its success will depend upon the voluntary cooperation, assistance, and understanding from other involved groups. The following is a list of groups which either are involved in or must be kept informed of all operational phases of an emergency program:

A. Other Federal, State, county, and municipal agricultural officials;

B. Grower groups;

C. Commercial interests;

D. Universities;

E. Florist groups;

F. State and local law enforcement officials;

G. Public health agencies;

H. Foreign agricultural interests;

I. National, State, and local news media; and

J. General public.

Addendum A--Definitions

Aerial Treatment:	Applying an insecticide by aircraft over a treatment area.
Aestivation:	A period of summer inactivity or dormancy during continued high temperatures or a dry season, carried out under shelter plants or litter.
Aestivating Area:	A local area where senn pest adults congregate to wait out unfavorable summer temperatures through aestivation.
Buffer Area:	The area extending beyond the boundary of the core--1- and 2-km (0.6- and 1.24-mi) buffer.
Central Cluster Injury:	An injury caused by feeding of the senn pest adult on the growing point of the immature shoot of the host, resulting in a withered and yellowed central leaf.
Commercial Production Area:	An area where host material is grown for distribution.
Confirmed Detection:	A positive identification by a recognized expert of a submitted life form (specimen) as senn pest.
Core Area:	A minimum distance of 1 km (0.6 mi) beyond any confirmed senn pest detection.
Delimiting Survey:	Determining the extent of the infestation in an area where senn pest has been detected.
Detection:	The collection of any life stage of senn pest.
Detection Survey:	An activity conducted in a susceptible area not known to be infested with senn pest.
Dry Leaf:	An injury to a leaf caused by feeding of the senn pest on the central vein of a leaf.
Epicenter/Focal Point:	An initial site of an infestation.
Eurygaster integriceps Puton:	The scientific name of the senn pest.
Fumigation:	The application of an approved fumigant as a treatment (methyl bromide).

Generation: (Life Cycle)	The period of time for the pest to complete all stages of development predicted by day degrees or on the basis of other biological information.
Ground Spray:	Using ground spray equipment to apply an insecticide to host vegetation in a senn pest infested area.
Heat Treatment:	The use of high temperatures as a treatment on selected products.
Hibernation:	A period of lethargy occurring during seasonal low temperatures and carried out under shelter plants or litter.
Host:	A plant species that provides for the potential reproduction of the senn pest.
Infestation:	The collection of two or more senn pest adults, a nymph, or a mated female from an area or the detection of a single adult determined to be associated with a current infestation.
Infested Area:	One km distance from all detection sites unless biological factors indicate the need for more or less area.
Kernel:	The fruiting body of graminaceous plants.
Migratory Flight:	Movement, en masse, of senn pest adults to another area either nearby or up to 80 km (50 mi) away in response to climatic conditions.
Monitoring/Evaluation Survey:	Visual and trapping surveys conducted in an area where an insecticide treatment has been applied to evaluate the effectiveness of the application.
New Generation Adult:	The new adults of the subsequent generation in a given year.
Nymph:	The immature form of senn pest. There are five stages, with progressively developed wing buds and size, but no wings.
Overwintered Adult:	The senn pest adults that have hibernated from the year past to spring of the subsequent year.

PPQ-APHIS-USDA	Plant Protection and Quarantine, Animal and Plant Health Inspection Service, U.S. Department of Agriculture.
Regulated Area:	An area that extends at least 1 lin km (.62 lin mi) in any direction from an infested property.
Regulatory Inspection:	Visual examination of host material and containers plus discretionary trapping conducted around establishments where regulated articles are grown, handled, processed, or moved.
Scarred Kernel:	Kernel attacked by senn pest nymph or adult and showing a round hole where feeding occurred or a scar in an older dried kernel. Such kernels are empty or, if attacked in the milky-white stage, fail to fill out.
Shelter Plant:	A plant species that provides covering shelter for senn pest adults from weather extremes.
Steam Sterilization:	The use of live steam as a treatment on selected products.
Trap Survey:	Determining the presence or absence of a pest by the use of traps with an attractant placed in a predetermined pattern and serviced on a given schedule.
Urban/Residential Area:	Noncommercial crop production area generally containing multiple- or single-family dwellings.
Visual Survey:	Examining hosts for eggs, nymphs, and adults either in the field or at regulated establishments, or in monitoring the movement of regulated articles.
White Ear:	An injury caused by feeding of the bug on the stem of the host just below the ear, resulting in a dry or white ear without kernels. This term applies to both small grains and corn.
Whitehead:	A head of mostly empty kernels which were attacked. This term also applies to corn ears which, in fact, are heads.

Addendum B--Safety

Personnel and public safety must be prime considerations at all times. Safety practices should be stressed in preprogram planning and through the duration of actual program operations. Supervisors must enforce on-the-job safety procedures. For complete instructions, see section V, D, in the Emergency Programs Manual.

Addendum C--Hosts

Senn pest hosts are listed by common and scientific names and are separated into preferred and other recorded hosts. In all instances, an attempt has been made to use the most widely recognized common name. A number of hosts have no common name and are given alphabetically at the end of this list.

PREFERRED

Common Name	Scientific Name
Barley	Hordeum vulgare
Brome grass	Bromus sp.
Bulbous barley	Hordeum bulbosa
Goatgrass	Aegilops spp.
Oats	Avena sativa
Rye	Secale cereale
Sorghum	Sorghum bicolor
Wheat	Triticum aestivum
Wheatgrasses	Agropyron spp.
Wild Grasses	Poaceae spp.

OTHER

Bindweeds	Convolvulus spp.
Camel thorn	Alhagi pseudahagi
Clover	Trifolium spp.
Common licorice	Glycyrrhiza glabra
Corn	Zea mays
Cotton thistle	Onopordum spp.
Flax	Linum spp.
Germander, A	Teucrium orientale
Knapweeds	Centaurea spp.
Milk vetch	Astragalus spp.
Spurge	Euphorbia spp.
St. Johnswort	Hypericum trigetrifolium
Sunflower	Helianthus spp.
Sunn hemp	Crotalaria juncea
Thistle	Cirsium rhizocephalum
Thistles	Carduus spp.
Vetch	Vicia spp.
White mustard	Sinapsis alba

NO COMMON NAME

Hypericum spp.
Leontice leontopetalum
Prosopis stephaniana
Texiera glastifolia

Addendum D--Life History

1. SYSTEMATIC POSITION

Senn pest complex, Eurygaster integriceps Puton (Hemiptera, Pentatomidae). In the broad sense.

Class: Insecta
Order: Hemiptera
Family: Pentatomidae

The genus Eurygaster consists of 23 species, 4 of these being found in North America. All the Old World species are found in Europe, particularly in the Mediterranean area. Four species range as far as China.

The North American species are E. alternata (Say), E. shoshone Kirkaldy, E. amerinda Dliven, and E. minidoka Dliven. None of these species are of any economic importance and appear to subsist on various sedges and grasses. The senn pest is the only economic species in the genus. Recent studies indicate that the senn pest, as now known, is actually a complex of nearly identical species with very similar habits. The information presented in this document is intended to cover all of these as yet undelineated species until more information becomes available. Currently, the species now identified as Eurygaster integriceps in the strict sense is considered to be the most important species in the complex. Four other species are recognized as important pests; two of these actually belong to the related genus Aelia. Seven other species in Aelia are known to cause occasional damage. The known members of the senn pest (also known as cerealbugs) complex are:

Major Pests

Eurygaster integriceps Puton
E. maura Linnaeus
E. austriaca Schaeffer

Aelia acuminata Linnaeus
A. rostrata Boheman

Occasional Pests

Aelia klugi Hahn
A. sibirica Reuter
A. triticiperda Kust
A. virgala Klug

A. furcula Fieber
A. cognata Fieber
A. germari Kust

2. IDENTIFICATION CHARACTERS

Some preidentification and sorting needs can be met by personnel assigned to the program.

The senn pest adult is a moderately sized bug about 11- to 12-mm long by 6-mm wide (about 1/2 by 1/4 in), somewhat oval and convex on dorsal side. The coloration is light brown, sometimes tending to a dark brown. Linear markings present with small

black spots in a patterned arrangement. Two features, a very prominent scutellum which is rather straight on the sides and which extends to the rear end and the smoothly rounded shoulders (anterolateral pronotal angles), are easily recognized with a little practice.

The genus Eurygaster is identified by the piercing, sucking mouthparts, large scutellum, front legs which lack heavy spines on the tibiae (forearm), the three-segmented tarsi (feet), visible antennae, eyes obviously present, rounded shoulders, brownish to yellowish color, and without a rough area on underside for stridation purposes.

The nymphs and eggs of the senn pest cannot be identified, except by association. The adult is separated from E. alternata by a more truncated pronotum and by a scutellum which is more abruptly narrowed at the rear.

Eggs: About 0.7 mm (0.028 in) diameter, spherical, a light blue green when freshly laid changing to light green with black dots up to a week later. With further development, red dots appear. When black and red dots appear together on one side, this forms the head and eyes, and the egg is close to hatching.

Nymphs: First instar very small, about 1.5-mm (0.06-in) long and 0.8-mm (0.03-in) wide, recognizably a bug with a dark brown to black head and thorax and brownish-yellow scutellum. Eyes red, antennae dark brown, legs grayish black. Margins of thorax and scutellum yellow, abdomen brown, blackish toward edges. Overall color light brown on emergence changing to blackish (as above) within the hour.

Second instar a little larger, grayish brown, thorax very dark brown, eyes and legs black, two black spots near center of body.

Third instar larger, 5.3-mm (0.2-in) long and 3.3-mm (0.13-in) wide, eyes black, antennae yellowish brown, body generally dark grayish brown, legs brownish yellow.

Fourth instar larger, 7.3-mm (0.28-in) long and 4.3-mm (0.17-in) wide, eyes slightly orange red, antennae yellowish brown, legs yellow, tarsi brown, two black spots near center of body, body generally dark grayish brown, scutellum lighter.

Fifth instar larger, 8- to 8.3-mm (0.3- to 0.33-in) long and 3.3-mm (0.13-in) wide, well developed thoracic structure and wing buds, eyes dark brown, dorsal side dark brown with black dots and arranged more or less in lines, legs brown, antennae brown to black.

black spots in a patterned arrangement. Two features, a very prominent scutellum which is rather straight on the sides and which extends to the rear end and the smoothly rounded shoulders (anterolateral pronotal angles), are easily recognized with a little practice.

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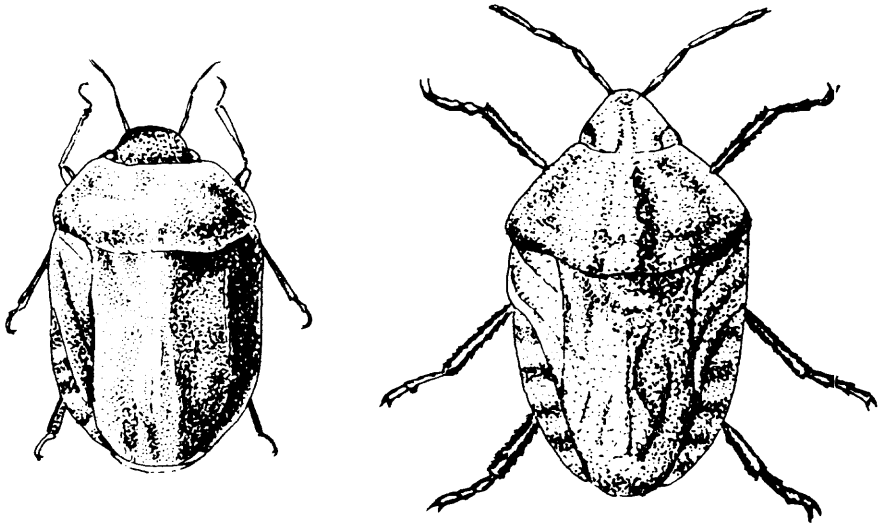
Figure 1—Identification of Senn Pest



Eurygaster alternatus (Say)

Eurygaster integriceps Puton

Figure 2—Color Variations

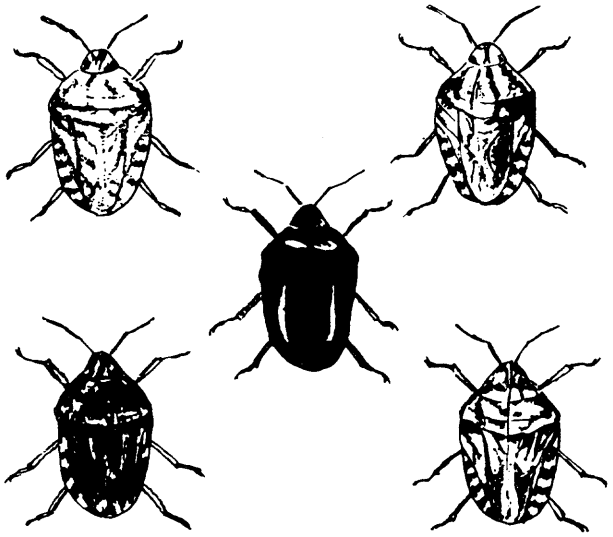


Figure 3—Adult and Nymph on a Wheat Head

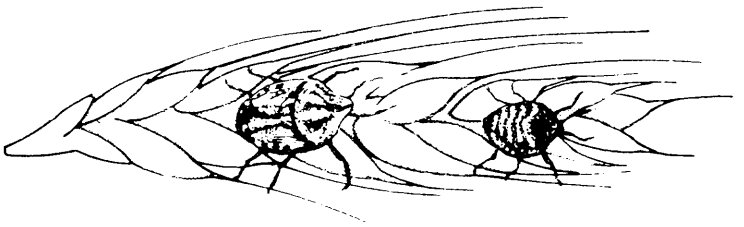


Figure 4—First Through Fifth Nymphal Stages

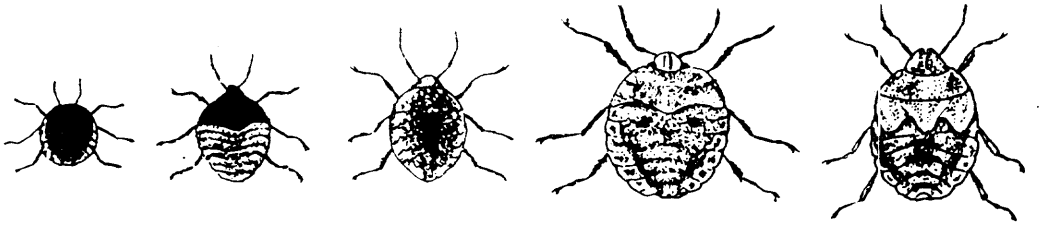


Figure 5—Batches of Eggs on Wheat Leaf

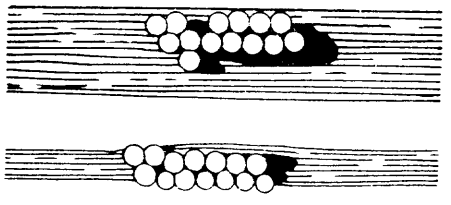
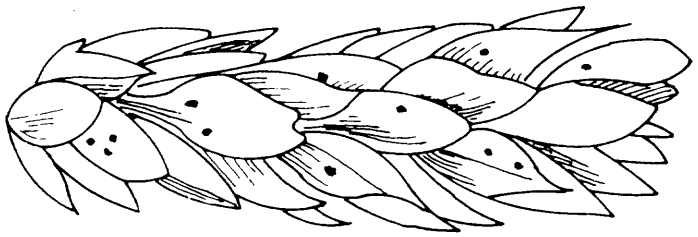


Figure 6—Damage to Wheat Kernels Caused by the Senn Pest



Adults: Length 11 to 12 mm (0.44 to 0.47 in). Body convex-oval on dorsal side, varying from yellowish brown to blackish depending on food, altitude, or temperature. Cool temperatures or higher altitudes result in lighter colors ranging to pale straw; high temperatures or lower altitudes result in colors ranging to deep brown. Certain foods, i.e., barley, result in blackish colors; other changes are a result of varietal differences in host, i.e., wheat. Markings vague, but often with two faint black streaks from vertex of head to scutellum, generally covered with small black spots in a linear pattern. Head triangulate, rounded in front, wider than long, mouthparts piercing, sucking. Scutellum extending beyond abdomen and almost covering it, with yellow line in middle and two yellow spots at base, variable to black. Dorsal margins of abdomen usually alternating light and dark areas. Ventral side paler, legs dotted with irregular brown spots, tarsi three-segmented, antennae five-segmented with last two darker.

3. BIOLOGY

A mated female bug lays its eggs on the leaves of cereal crops or weeds such as found in the Fabaceae (inc. legumes), Asteraceae (composites), and Poaceae (grasses). The eggs are laid in batches of 12 to 14 in 2 rows. The female may lay 5 to 6 batches for a total of 60 to 84 eggs on average when conditions are poor and up to 260 on average over several months when conditions are good.

The eggs take about 1 to 3 weeks to hatch, going through a number of color and appearance changes as they mature. The first instar nymphs, on emergence, stay near the empty eggshells for 1 or 2 days and do not feed. They then spread onto plants and

soil and moult in about 1 week. Second instars feed on fresh leaves. Successive moults occur at 5- to 6-day intervals. After the fifth moult, the adult stage is attained.

By the time the new generation of adults has appeared, the majority of overwintering adults are dead. The new adults feed on heads during the cooler hours of the day. Many bugs may move down to cracks in the soil or crawl under weeds if the temperature is high, but not all will do so.

During this time, the adults build up adequate food reserves for aestivation/ hibernation by feeding on heads and kernels for about 10 to 15 days. If the host ripens before reserves are complete, adults will feed on the dry kernels and pick up moisture from green, moist, leafy weeds, dew, or any precipitation. It is necessary for adults to feed on nutrients high in protein in order to build up fat reserves. If a host is harvested or is otherwise unavailable, the adults may migrate to nearby fields of later maturing hosts or weeds in order to complete reserve food storage.

In hot, dry areas, the adult then flies (about June or July) up to 80 km (50 mi) to hilly or mountainous regions where crops are not yet mature (due to a colder climate) and feed on these for approximately 10 days or so before actually aestivating by crawling underneath sheltering shrubs, leaf litter, and the like. In areas where hot, dry weather is not a problem, the bugs may simply migrate to nearby hosts until fall. In all cases, migration to winter hibernation sites occurs in the fall. These sites are generally at lower elevations where it is not so cold or in other areas into nearby woods. The bugs generally settle on patches of wild grass. They may feed a little, but with decreasing temperatures dig underneath shelter plants, even going as deep as 12 cm (4.7 in). Plants such as Astragalus spp., Artemisia spp., and Acantholimon venustrum provide such shelter. A small number of bugs may overwinter in vineyards, orchards, and the like. Snow cover actually adds to the shelter and may even be critical to survival. Some mortality occurs and can be severe if the insects were not able to store sufficient reserves. Males are more susceptible than females, and the normal sex ratio of 1:1 is altered during hibernation to 2:1 for females.

After the snow melts and the temperature reaches 64.4 ^{o}F (18 ^{o}C) (the threshold value for flight is 60.8 ^{o}F (16 ^{o}C)), the adults emerge and begin spring migration. The migration lasts 2 to 3 weeks or longer if the weather is cold. On leaving the shelters the bugs stand on the soil for a while, then fly a few meters. This distance gradually increases until sustained flight takes place. At this point, the bugs can rise vertically several dozen meters if necessary, and if in forest, to clear the treetops. Generally, flights are individual and just appear to be synchronized if other bugs are flying in the same direction. Flight starts first toward open spaces (positive phototaxis) then toward host fields. Wind is a factor and must be considered when working out overall flight direction. Since the bugs tend to fly with the wind, if winds blow one direction in fall and the opposite direction

in spring, then the overwintering adults may actually "return" to the same (or nearby) fields that they left. In any event, the distance between the overwintering areas and suitable host fields is covered, and the bugs generally take shelter in the soil or hide under weeds or among stems, as they are still sensitive to cold and rain. With some variation, feeding takes place for up to 10 to 15 days. Mating may occur 1 to 2 days after the fields are reached or only after 10 to 15 days, depending on the physiological condition of the bugs. This period allows the ovaries and accessory sexual glands in the female to develop. Generally, the female will not mate until terminal oocytes (eggs) are mature and the accessory sexual glands are active. Such development depends on adequate feeding. Male sexual maturity is independent of feeding and may occur before the migratory flight. It is temperature dependent, commencing after engorgement for hibernation, with a threshold of 33.8 ^{o}F (1 ^{o}C) and a summation of 1100 day degrees to maturity. Males emit a scent like vanilla (which man can detect) to attract the female. Eggs are laid about a week after mating. Overwintered adults may start to die 10 to 15 days after they arrive in the fields and are usually all dead 1 or 2 months later, depending on local conditions.

The senn pest flies only when it migrates. It rarely moves except to feed or go from host to host by walking. There is some vertical movement, especially if it is very hot, when the insect might descend to the ground in search of cover during the day. Overwintered individuals which have fed, mated, and oviposited show no tendency to fly and appear to lose this ability after a month or so.

In all migrating populations, some of the individuals remain in the area to aestivate or hibernate. If conditions are favorable, these individuals may be able to complete the life cycle in such locations. Generally, wild grasses must be present, preferably cereals.

Most feeding takes place in early morning (i.e., 8 a.m.) and again in mid to late afternoon (i.e., 4 p.m.), but feeding can take place at any time. Overwintering adults feed on the growing points of the immature shoots of the host. This feeding results in a withered and yellow central leaf called central cluster injury. This injury is serious and prevents tillering by the host. Sometimes the central vein of a leaf is attacked, causing dry leaf; such damage is not serious. When the host begins to head, the bug may feed on the stem just below the head. This causes dry ear or white ear injury and is extremely damaging. The nymphs from the third instar on and young adults will attack the grains, resulting in pierced and empty kernels. Such damage has resulted in total crop loss. Feeding, in general, can be stimulated by the influence of positive phototaxis, provided other factors such as temperature do not intervene.

The life cycle given above takes 1 year. The senn pest may be inactive in aestivation or hibernation for up to 9.5 months of the year and active for only 2.5 months or so.

During this short period of activity, it carries out the remainder of its life stages from egg to adult and stores fat to carry it through to the following year. Optimal conditions are 75.2 to 82.4 °F (24 to 28 °C) with relative humidity 60 to 65 percent. Mortality is high in the first two nymphal instars, low in subsequent instars. Minimal temperatures for survival of the life stages are as follows: eggs, 28.4 °F (-2 °C) no development, 14 °F (-10 °C) lower critical limit; nymphs, survival up to 4 days at 27.5 °F (-2.5 °C); hibernating adults, fall, 17.6 °F (-8 °C), spring 24.8 °F (-4 °C). Hibernating adults are protected by a layer of litter under a layer of snow and thus are not normally exposed to temperatures below critical limits. An exception occurs if snow melt takes place, removing the protective snow cover. If temperatures then dip, mortality may develop among exposed bugs whose resistance is lower due to depletion of fat reserves.

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The eggs take about 1 to 3 weeks to hatch, going through a number of color and appearance changes as they mature. The first instar nymphs, on emergence, stay near the empty eggshells for 1 or 2 days and do not feed. They then spread onto plants and soil and moult in about 1 week. Second instars feed on fresh leaves. Successive moults occur at 5- to 6-day intervals. After the fifth moult, the adult stage is attained.

By the time the new generation of adults has appeared, the majority of overwintering adults are dead. The new adults feed on heads during the cooler hours of the day. Many bugs may move down to cracks in the soil or crawl under weeds if the temperature is high, but not all will do so.

During this time, the adults build up adequate food reserves for aestivation/ hibernation by feeding on heads and kernels for about 10 to 15 days. If the host ripens before reserves are complete, adults will feed on the dry kernels and pick up moisture from green, moist, leafy weeds, dew, or any precipitation. It is necessary for adults to feed on nutrients high in protein in order to build up fat reserves. If a host is harvested or is otherwise unavailable, the adults may migrate to nearby fields of later maturing hosts or weeds in order to complete reserve food storage.

In hot, dry areas, the adult then flies (about June or July) up to 80 km (50 mi) to hilly or mountainous regions where crops are not yet mature (due to a colder climate) and feed on these for approximately 10 days or so before actually aestivating by crawling underneath sheltering shrubs, leaf litter, and the like. In areas where hot, dry weather is not a problem, the bugs may simply migrate to nearby hosts until fall. In all cases, migration to winter hibernation sites occurs in the fall. These sites are generally at lower elevations where it is not so cold or in other areas into nearby woods. The bugs generally settle on patches of wild grass. They may feed a little, but with decreasing temperatures dig underneath shelter plants, even going as deep as 12 cm (4.7 in). Plants such as Astragalus spp., Artemisia spp., and Acantholimon venustrum provide such shelter. A small number of bugs may overwinter in vineyards, orchards, and the like. Snow cover actually adds to the shelter and may even be critical to survival. Some mortality occurs and can be severe if the insects were not able to store sufficient reserves. Males are more susceptible than females, and the normal sex ratio of 1:1 is altered during hibernation to 2:1 for females.

After the snow melts and the temperature reaches 64.4 ^{o}F (18 ^{o}C) (the threshold value for flight is 60.8 ^{o}F (16 ^{o}C)), the adults emerge and begin spring migration. The migration lasts 2 to 3 weeks or longer if the weather is cold. On leaving the shelters the bugs stand on the soil for a while, then fly a few meters. This distance gradually increases until sustained flight takes place. At this point, the bugs can rise vertically several dozen meters if necessary, and if in forest, to clear the treetops. Generally, flights are individual and just appear to be synchronized if other bugs are flying in the same direction. Flight starts first toward open spaces (positive phototaxis) then toward host fields. Wind is a factor and must be considered when working out overall flight direction. Since the bugs tend to fly with the wind, if winds blow one direction in fall and the opposite direction in spring, then the overwintering adults may actually "return" to the same (or nearby) fields that they left. In any event, the distance between the overwintering areas and suitable host fields is covered, and the bugs generally take shelter in the soil or hide under weeds or among stems, as they are still sensitive to cold and rain. With some variation, feeding takes place for up to 10 to 15 days. Mating may occur 1 to 2 days after the fields are reached or only after 10 to 15 days, depending on the physiological condition of the bugs. This period allows the ovaries and accessory sexual glands in the female to develop. Generally, the female will not mate until terminal oocytes (eggs) are mature and the accessory sexual glands are active. Such development depends on adequate feeding. Male sexual maturity is independent of feeding and may occur before the migratory flight. It is temperature dependent, commencing after engorgement for hibernation, with a threshold of 33.8 ^{o}F (1 ^{o}C) and a summation of 1100 day degrees to maturity. Males emit a scent like vanilla (which man can detect) to attract the female. Eggs are laid about a week after mating. Overwintered adults may start to die 10 to 15 days after they arrive in the fields and are usually all dead 1 or 2 months later, depending on local conditions.

The senn pest flies only when it migrates. It rarely moves except to feed or go from host to host by walking. There is some vertical movement, especially

if it is very hot, when the insect might descend to the ground in search of cover during the day. Overwintered individuals which have fed, mated, and oviposited show no tendency to fly and appear to lose this ability after a month or so.

In all migrating populations, some of the individuals remain in the area to aestivate or hibernate. If conditions are favorable, these individuals may be able to complete the life cycle in such locations. Generally, wild grasses must be present, preferably cereals.

Most feeding takes place in early morning (i.e., 8 a.m.) and again in mid to late afternoon (i.e., 4 p.m.), but feeding can take place at any time. Overwintering adults feed on the growing points of the immature shoots of the host. This feeding results in a withered and yellow central leaf called central cluster injury. This injury is serious and prevents tillering by the host. Sometimes the central vein of a leaf is attacked, causing dry leaf; such damage is not serious. When the host begins to head, the bug may feed on the stem just below the head. This causes dry ear or white ear injury and is extremely damaging. The nymphs from the third instar on and young adults will attack the grains, resulting in pierced and empty kernels. Such damage has resulted in total crop loss. Feeding, in general, can be stimulated by the influence of positive phototaxis, provided other factors such as temperature do not intervene.

The life cycle given above takes 1 year. The senn pest may be inactive in aestivation or hibernation for up to 9.5 months of the year and active for only 2.5 months or so.

During this short period of activity, it carries out the remainder of its life stages from egg to adult and stores fat to carry it through to the following year. Optimal conditions are 75.2 to 82.4 ^{o}F (24 to 28 ^{o}C) with relative humidity 60 to 65 percent. Mortality is high in the first two nymphal instars, low in subsequent instars. Minimal temperatures for survival of the life stages are as follows: eggs, 28.4 ^{o}F (-2 ^{o}C) no development, 14 ^{o}F (-10 ^{o}C) lower critical limit; nymphs, survival up to 4 days at 27.5 ^{o}F (-2.5 ^{o}C); hibernating adults, fall, 17.6 ^{o}F (-8 ^{o}C), spring 24.8 ^{o}F (-4 ^{o}C). Hibernating adults are protected by a layer of litter under a layer of snow and thus are not normally exposed to temperatures below critical limits. An exception occurs if snow melt takes place, removing the protective snow cover. If temperatures then dip, mortality may develop among exposed bugs whose resistance is lower due to depletion of fat reserves.

Addendum E--Identification of Specimens

As many specimens as possible of the pest are to be collected for identification by the local designated identifier. Suspect adult and associated nymphal specimens should be forwarded dry in a small cardboard box for confirmation to 1/ below. These specimens must be accompanied by PPQ Form 391 marked "Urgent" (see PPQ Manual M390.500).

INFORMATION FLOW FOR THE IDENTIFICATION OF INSECTS

SPECIMEN COLLECTED

SCREENING/IDENTIFICATION BY STATE OR PPQ

SPECIMEN SUBMITTED TO USDA 1/
for Confirmation
CONFIRMATION NOTIFICATION 2/
to Other USDA Agencies

RESULTS SENT TO APHIS AND IF EXOTIC,
Information Relayed to 2/ 3/

APHIS/ARS 1/	All States 2/	NAPPO 3/

1/ ARS — Biosystematics and Beneficial Insects Institute
Agricultural Research Service
U.S. Department of Agriculture
Building 003, BARC-WEST
Beltsville, Maryland 20705

APHIS — Plant Protection and Quarantine

2/ All States — State and Territory Agricultural Regulatory Officials

3/ NAPPO — North American Plant Protection Organization

Addendum F--Forms

To be added later.

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Addendum H--References

The literature on senn pest is extensive. Articles relevant to this Action Plan are listed here. Some work seems to have been carried out on sterile insects, and there is a large number of papers on parasites.

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