Biology of Insect Pests of Soybean and Their Control

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Soybean plants are attacked by various kinds of insect pests and 218 species (belonging to 61 families of 9 orders) of them are known to be distributed in Japan.

These insect pests are classified by taxonomical orders and attacked parts on soybean plants as shown in Table 1, which indicates that most of them are included in Lepidoptera, Hemiptera and Coleoptera in this order, and the ones attacking the leaves are predominant in number, being followed by stem and pod attackers. But heavy damage to the soybean crop is caused by the species which directly attack the pods (including seeds).

Damage caused by insect pests to the soybean crop varies with the year and place, and there is a tendency that the total amount of damage by various insect pests is greater in warm regions, islands, piedmont districts and warm years than in cold regions, inland areas, plains and cold years, respectively.

For example, the mean percentages of total wormy beans in each prefecture range from about 17 to 56 per cent at the time of harvest as shown in Table 2. If the damage is classified by kinds of insect pests, that by stink bugs is predominant, forming about 14 to 38 per cent of the total wormy beans in warm regions, while soybean pod borers do the major part, about 10 to 14 per cent, of damage in cold regions.

Biology and control of important insect pests

About 30 species of insect pests which cause severe damage to soybean plants are distributed in Japan, but in this article descriptions are made only about stink bugs and pod borers because of space limitations. These are the insects constantly causing a great deal of damage to the crop.

Stink bugs (Hemiptera)

Among about 30 species of stink bugs which are known to attack the soybean crop, the following four species are the most injurious:

1) *Nezara antennata* SCOTT (Pentatomidae)

(Common green stink bug, Fig. 1)

Distribution: Japan (whole land), Korea, Formosa, China and Tibet, etc.

Food plants: About 80 species belonging to Leguminosae, Gramineae, Solanaceae, Pedaliaceae, Compositae and 20 other families (Kobayashi 1959).

Life history: The present species has two generations a year. In the Shikoku district, adults after hibernation become active when the weather grows so warm that the maximum temperature reaches 14 to 15°C, and females lay eggs on broad beans, peas and Chinese milk vetches, etc. during a period from the end

Table 1. Number of species of insect pests classified by orders and attacked parts on soybean plants

Attacked parts	Order										Percentage of species	Percentage of attacked parts
	Collembola	Orthoptera	Dermaptera	Thysanoptera	Hemiptera	Lepidoptera	Coleoptera	Hymenoptera	Diptera	Total		
Root	1	1	—	—	3	—	8	—	4	17	7.8%	5.4%
Stem	—	7	—	1	49	9	8	—	3	77	35.3	24.2
Leaf	2	13	1	8	40	73	35	2	8	182	83.5	57.2
Flower	—	—	—	4	—	1	1	—	—	6	2.8	1.9
Pod	—	4	—	—	24	7	—	—	1	36	16.5	11.3
Total	2	19	1	9	55	77	40	2	13	218	—	

Note: Attacked parts were classified on the following bases:

1) Root: Roots, root tubercles and subterranean parts of stems
2) Stem: Most parts of stems, and petioles
3) Leaf: Cotyledons, youg and developed leaves
4) Flower: Flowers and flower buds
5) Pod: pods and seeds

From data of Kuwayama (ed. 1953)

Table 2. Percentages of insect-damaged seeds classified by pest species at the time of harvest

District Prefecture	Percentage of damaged seed classified by pest species							Remarks			
	Stink bugs	Pod gall midge	Lima bean pod borer	Adzuki pod worm	Soybean pod borer	Others	Total	Number of places for examination or soybean varieties examined	Year of examination	Years for examination	Literature
Tohoku											
Aomori	1.5	0.1	0.1	1.1	13.8	0.3	16.9	17.0	'67～'70	4	Kobayashi (unpublished)
Iwate	2.4	0.6	0.0	0.6	14.2	0.1	17.9	25.3	〃	4	〃
Akita	2.1	1.2	0.2	3.4	12.7	0.3	19.9	14.3	〃	4	〃
Miyagi	3.0	2.9	0.2	2.6	10.6	0.3	19.6	22.2	'66～'70	5	〃
Yamagata	3.0	2.0	0.2	1.9	14.4	0.3	21.8	27.5	'67～'70	4	〃
Fukushima	6.0	2.6	0.4	2.3	10.1	0.4	21.8	20.5	'67, '69	2	〃
Kanto-Tozan											
Nagano	34.4	2.4	11.6	—	—	2.4	50.8	24	1952	1	Chiku & Miyashita (1957)
Chiba	17.4	4.5	7.9	—	—	—	29.8	5	1953	1	Ichihara (1964)
Shikoku											
Kagawa	37.9	1.9	4.0	11.4	1.0	—	56.2	33	1950	1	Ishikura et al. (1952)
Tokushima	13.9	0.1	0.1	8.2	6.2	—	28.5	4	1950	1	〃

of April to the beginning of July when these plants are bearing fruits.

A female lays about 110 eggs in about 2.6 masses on an average. Eggs hatch in four to six days. The larval period is about 20 to 27 days through five instars. Adults of the first generation lay eggs on soybeans, red beans and string beans, etc. during a period from the end of June to the middle of September when these plants are bearing fruits.

Adults of the second generation appear about one to two months later, and hibernate in sunny clusters of grass, thickets of evergreen trees, and the like. Adults are well attracted by blue fluorescent lamps.

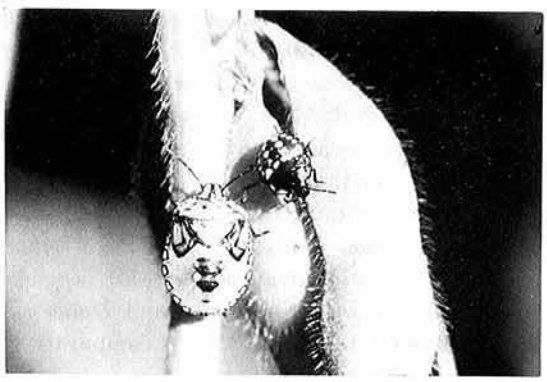

Fig. 1. Fourth and fifth instar nymphs of *Nezara antennata* on a soybean plant

2) *Piezodorus hybneri* GMELIN (Pentatomidae)
(One-banded stink bug)

Distribution: Japan (Honshu, Shikoku and Kyushu), Formosa, China, India, tropics of the East, Australia and North Africa, etc.

Food plants: Leguminosae and *Veronica* spp.

Life history: This species appears to have three generations a year in the Shikoku district. Adults after hibernation become active as early as the above-mentioned species and lay eggs in May or so. Adults of the first generation appear in June to July, and those of the second generation are seen in August to September. Adults of the third generation come into sight one to two months after that, and hibernate in sunny clusters of grass, and the like. A female lays about 170 eggs in seven masses or so. Eggs hatch in three to five days. The larval period is about 16 to 21 days through five instars. Adults are attracted by blue fluorescent lamps.

3) *Dolycoris baccalum* LINNÉ (Pentatomidae)
(Sloe bug)

Distribution: Japan (whole land), Korea, Saghalien, China, India, Siberia and Europe, etc.

Food plants: About 50 species belonging to Leguminosae, Compositae, Liliaceae, Pedaliaceae and nine other families.

Life history: This species resembles *Nezara antennata* in life history. Adults are not attracted by blue fluorescent lamps.

4) *Riptortus clavatus* THUNBERG (Coreidate)
(Bean bug)

Distribution: Japan (whole land), Formosa and Korea.

Food plants: About 30 species belonging to five families, Leguminosae, Gramineae, Convolvulaceae, Rosaceae and Pedaliaceae.

Life history: The present species has three generations a year in the Shikoku district. Adults after hibernation become active at about the beginning of April and lay eggs from the middle of May to the beginning of July. Adults of the first generation appear from the end of June to the end of July to lay eggs from the middle of July to the end of August. Individuals of the second generation become adults from the middle to end of August and oviposit from the end of August to the beginning of October. Adults of the third generation appear from the beginning of October to the beginning of November and winter in sunny clusters of grass. A female layes 55 to 90 eggs separately. Eggs hatch in six days. The larval period is 16 to 23 days through five instars. Adults are attracted by blue fluorescent lamps.

5) *Damage to the soybean crop*

Time of infestation: The stink bugs are

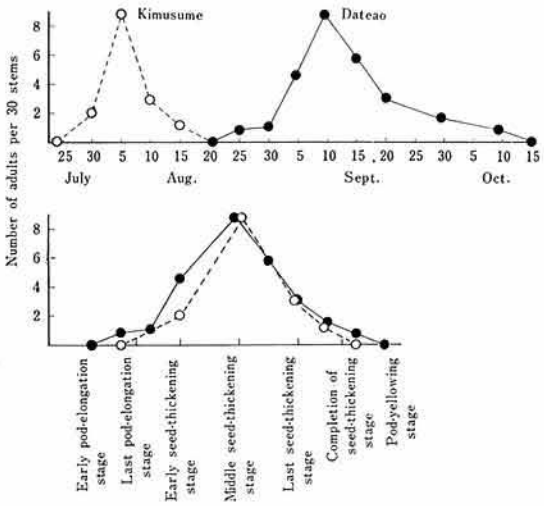

Fig. 2. Changes in population density of adult *Nezara antennata* and *Piezodorus hybneri* on two varieties of soybeans, Kimusume and Dateao

fond of sucking juice from developing seeds as shown in Fig. 2. When two soybean varieties are different from each other in podding time, the population density of stink bugs reaches the peak on a different day on these varieties. But if examined from a developmental stage of seeds, the density shows a similar tendency of changes on both varieties, having the peak at the middle stage of seed development.

Amount of damage: The occurrence of bug-damaged beans is variable in frequency according to the developmental stage of pods and seeds at the time of attack, and the younger they are, the higher the frequency is.

Experimental studies of the attack of *Nezara antennata* on soybean plants were carried out for 10 days between the end of July and the end of August in two years, showing that the number of beans attacked by a bug was 4.5 in the pod-elongating period, 3.6 in the early stage, 3.0 in the middle stage and 1.4 in the last atage of the seed thickening period per day.

The frequency of damage to beans also varies with the species of stink bug. When four individuals each of different species of stink bugs were allowed to inflict damage for 10 days late in September when soybean plants were a suitable stage for their attack, the number of beans damaged by *Piezodorus hybneri, Nezara antennata, Riptortus clavatus* and *Dolycoris baccalum* was larger in this order as shown in Table 3.

In addition, the aspect of attack differs with species. For instance, *Riptortus clavatus* has a tendency to attack young seeds preferably, *Piezodorus hybneri* is apt to damage beans severely in a little advanced stage of development, while *Nezara antennata* and *Dolycoris baccalum* tends to damage beans comparatively lightly in this stage (Fig. 3).

6) *Method of control*

As damage by stink bugs is generally lighter in late-blooming varieties of soybean, it is effective for avoiding their attack to select varieties and change the time of seeding so that the peak of the occurrence of stink bugs does not coincide with the podding period

Table 3. Comparison of the number of beans damaged by four species of stink bugs

Species	Early stage of seed-thickening period	Middle and last stages of seed-thickening period		Total	Number of beans damaged by a bug per day
	Number of severely damaged beans	Number of severely damaged beans	Number of lightly damaged seeds		
Nezara antennata	10.8	31.5	31.0	73.3	1.83
Piezodorus hybneri	17.5	60.0	8.8	86.3	2.16
Dolycoris baccalum	6.0	28.5	24.0	58.5	1.46
Riptortus clavatus	29.0	31.3	2.0	62.3	1.56

Note: From data of Ishikura et al. (1955)

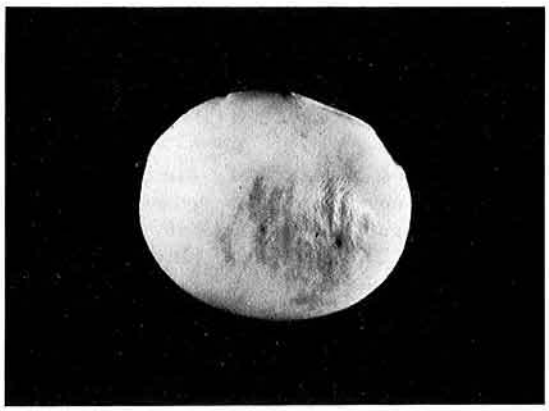

Fig. 3. Appearance of a soybean lightly damaged by a stink bug at the last stage of the seed-thickening period

of soybean plants.

It is also recommended to spray the plants with a 0.05 per cent solution of MPP, CYAP, MEP or EPN, or apply a dust of them two or three times at intervals of about 10 days from the beginning of the podding period.

From the viewpoint of safety and preventing public nuisance, chemicals strong in acute and residual toxicity are not included in the above-mentioned (this applies to the following cases).

Pod worms (Lepidoptera and Diptera)

Three species of Lepidopterous insects and the pod gall midge (*Asphondylia* sp., Diptera, Cecidomyiidae) are known to bore into soybean pods and eat away the seeds. But only the former is dealt with in this article.

1) *Leguminivora glycinivorella* MATSUMURA (Eucosmidae)
(Soybean pod borer)

Distribution: Japan (whole land), Korea, Manchuria and Siberia, etc.

Food plants: Soybean, *Glycine ussuriensis* and *Pueraria triloba*.

Biology: The present species has one generation a year in cold regions and adults appear about the blooming period (August) of soybean plants. In warm regions it sometimes has two peaks of occurrence, that is in the early to middle part of August and toward the end of September. Females lay eggs selectively on young pods, especially on those just after the completion of elongation.

Eggs hatch in seven to nine days. Hatched larvae bore into the pods and eat away the seeds, and finally come out of the pods to hibernate in the larval stage in the ground.

Damage by this species differs in degree with the variety of soybean because the borers lay fewer eggs on varieties which have no hairs on the pods and the mortality of larvae in pods is variable according to the variety of host plant.

In general, the damage tends to be lighter in long-leafed strains and in both extra early- and late-maturing varieties of soybeans by reason that in the former the mortality of larvae is higher and in the latter the appearance of adults does not coincide with the podding period of the plants (Nishijima and Kurosawa 1953, Matsumoto 1962).

Method of control: Select suitable varieties lighter in damage, and think out a seeding plan. Carry out mixed cultivation with tall crops, as corn, and also crop rotation on a large scale. Apply the same insecticides as used for controlling stink bugs two times or so in the period of peak oviposition (about four weeks after the full blossom in the case of late-maturing varieties).

2) *Etiella zinckenella* TREITSCHKE (Pyralidae)
(Lima bean pod borer)

Distribution: Japan (whole land), Korea, Manchuria, Siberia, China, Formosa, India, Africa, Europe and America, etc.

Food plants: Soybean, pea, string bean, kidney bean, Lima bean, *Glycine ussuriensis*, *Vicia* spp., *Lathyrus* spp. and other pulse.

Biology: This species occurs three times a year in the Kanto district and four times in the Tokai and Shikoku districts. It hibernates in the larval stage in the ground or various

kinds of deposits.

An adult female lays one to three eggs each on a pod, 60 to 200 in total. Eggs hatch in five to seven days and hatched larvae bore into pods and eat the seeds.

When seeds are small in size, larvae which ate them up make small round holes on the pods and come out of them to invade another pods. Larvae which matured in about 20 days come out of the pods and pupate in the ground or others.

The pupal period is about 10 days. This insect pest does more damage to the summer or mid-season crop of soybean than to the autumn crop (Ishikura et al. 1953).

Method of control: In warm regions where the insects occur repeatedly in a year, it is difficult to avoid the damage by the selection of seeding time. Apply a 0.05 per cent solution or a dust of MPP, CYAP or EPN two times or so in the young pod period.

3) *Matsumuraeses phaseoli* MATSUMURA (Eucosmidae)
(Adzuki pod worm)

Distribution: Japan (whole land), Formosa and India, etc.

Food plants: Leguminous plants, as soybean, red bean, pea, broad bean and kidney bean, etc.

Biology: This species has three to four generations a year in the Shikoku district, and young larvae sometimes bind young leaves of broad bean plants together to hibernate among them.

On summer soybean and kidney bean plants which were sowed in spring, the worms first bind young leaves together to eat them, and then bore into the stems, often doing severe damage to them by stopping growth and breaking stems and branches.

On autumn soybean plants, the worms bind several pods, or pods and leaves or branches together and eat their epidermis as well as the seeds. As for the biology of this insect pest, many problems remain unexplained.

Method of control: Apply the same insecticides as used for controlling the former species at the beginning of damage.

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