Source: Insect Pests of Soybean in Japan and their Distribution, by Satoru Kuwayama (1953) Tokyo, Japan: Yokendo. Pp. 1-11, 16-21, 22, 26-27.
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I. INTRODUCTION

Soybeans have been cultivated in East Asia since days of old. The unique characteristic of being a food source containing both proteins and fats make soybeans an essential part of Japanese life, not only as the raw materials for *miso* and soy sauce, but also *tofu*, *natto*, bean sprouts, *edamame*. Soybeans have come to be so popular that there is hardly a meal in which they do not appear on the table in some form. Soybeans are also valued for their fats and oils, casein and other derivatives that are used as raw materials in industry, as feed for animals, as well as fertilizer. In addition to direct use as described above, soybeans are considered an important crop for improving soil quality because of nitrogen fixation by symbiotic rhizobacteria. Japan has a climate suitable for growing soybeans, and it is ubiquitously cultivated, along with rice, wheat and, root crops from Hokkaido in the north to Kyushu in the south. The following table summarizes recent production of soybeans in Japan.

Annual Soybean Production in Japan[1]

Year	Dried Soybeans			Immature Soybeans			Green-cut Soybeans		totals
	production area	yield per *Han*	total yield	production area	yield per *Han*	yield	production area	yield	production area
	1000 *cho**	Seki**	1000 seki**	1000 *cho*	Kan***	1000 kna***	1000 *cho*	1000kan***	1000 seki
1946	226	0.691	1,566	7	112	8,026	57	111,859	290
1947	225	0.598	1,345	10	106	10,603	43	110,257	278
1948	232	0.716	1,659	7	127	8,579	47	110,426	286
1949	256	0.656	1,681	7	142	10,354	41	92,153	304
1950	299	0.836	2,503	6	153	9,890	38	102,979	343

* 1 seki ≈ 9930m^2
** 1 cho ≈ 190.3L
*** 1 kan ≈ 3,75kg

Until now, domestic production of soybeans could not meet domestic demand, and this deficit was filled by importing vast quantities from foreign countries; the difficulties in trade after the end of the war (WWII) has resulted in a sudden realization of the need for increased domestic production. Still, although soybean production is relatively easy, the low profitability compared to other crops and competition of cheap soybeans from Manchuria left much to be desired of domestic research on soybeans. In order to increase production, priority should be given to research in improving yield rather than to increasing areas of production. It is necessary to develop better cultivars, apply scientific approaches to improving cultural practices, methods for inoculating rhizobacteria, and protection against yield loss due to insects. In recent years, it has become apparent, in large part due to this study, that much of the so-called unproductive areas and poor yield is attributable to insect damage. The need to identify the major insect pests of soybeans in our country, their ecology, distribution and degree of damage caused by each was the

[1] Adapted from the Agriculture, Forestry and Fisheries Ministry statistics pocketbook (1952)

motivation for this study. The following is a summary of the major insect pests that have been recorded in recent years in various regions of the country, to which the present study, thanks to the extraordinary effort of the researchers involved, has contributed many new species.

Regarding soybean insect pests in our country, Matsumura (1906) and Omohara (1941) identified 24 and 74 species, respectively. Although those reports included observations outside present-day national boundaries and what are clearly mistakes, Uchida (1951) recently reported 129 species. Furthermore, Iijima (1951) identified more than 80 species and reported that, "combining this with the 1948 study results, 52 species of soybean insect pests are found in Hokkaido, 68 in the Hokuriku region, 15 in the Kanto region, 22 on Shikoku island, and 48 on Kyushu island. Kuwayama (1926, 1948) reported 33 soybean pest species in Hokkaido, but recently revised the count to 46; Sugiyama and Mochizuki (1949) identified 43 species in the Hokuriku region; Itoga and Yamashita (1950) counted 47 species in *Kagoshima* prefecture [Kyushu island]; and Matsunaga (1951) recently reported 66 species in the Kyushu region. While some of these species are found in more than one region, others are unique to one region; but even if an insect is found in more than one region, population density and amount of damage caused may differ by region. The following is a catalog of the soybean insect pests:

(see Appendix 2)

III. Distribution of Soybean Insect-Pests and their Characteristics

Soybean insect-pests in Japan as identified in the present study and listed in the previous section comprise 9 orders, 61 families, and 218 genera[2].

Summary of Soybean Insect-Pests in Japan

Order	Family	Genus	Percentage of all genuses
1. Collembola	2	2	0.9%
2. Orthoptera	5	19	8.7
3. Dermaptera	1	1	0.5
4. Thysanoptera	3	9	4.1
5. Hemiptera	20	55	25.2
6. Lepidoptera	15	77	35.3
7. Coleoptera	8	40	18.4
8. Hymenoptera	2	2	0.9
9. Diptera	5	13	6.0
Total	61	218	100.0

As can be seen in the table above, Lepidoptera make up over one-third of the total insect-pests, followed by Hemiptera and Coleoptera, and Orthoptera, Diptera, and Thysanoptera numbers are substantially smaller. The most interesting observation regarding the soybean insect-pests is that Orthoptera species such as *Oxya velox*, *Oxya japonica*, *Atractomorpha bedeli*, *Homorocoryphus jezoensis*, and Hemiptera such as *Leptocorisa varicornis*, which are known to be pests of rice, feed on soybeans planted on ridges between rice paddies; Coccoidea such as *Icerya purchasi* and *Icerya seychellarum* that infest *kan* and *tachibana* (citrus), leaf-curl insects such as *Pandemis heparana*,

[2] After writing this report, it became clear that two species should be added to the list: *daizuhanatamabae* (scientific name unknown), observed by Mochizuki (Agriculture and Insect Pests, vol. 5, 90~92, summer, 1951) in the Hokuriku region; *Sceptieus tigrinus* ROELOFS, observed causing damage this year (1952) in the Oshima region of Hokkaido.

Archips ingentanus, Tortrix sinapina, Cacoecia sorbiana, Cacoecia breviplicana that attack water weeds, as well as *Plateumeta aurea* BUTLER、*Narosoideus flavidorsalis* often infest soybeans which are frequently planted as a cover crop or green manure crop in orchards; also, *Pseudococcus comstocki, Pseudaulacaspis pentagona,* or larvae of *Spilosoma imparilis* often invade soybeans intercropped between mulberries. Among insects that were previously known to be pests on soybeans, there are a few that feed exclusively on soybeans or only on a limited number of bean species; the majority of pests, however, are polyphagous. It is not surprising that soybean has pests in common with rice, fruit trees, and mulberries; the fact that soybeans, due to the suitability of the environment, are grown widely both in space and time and for many purposes contributes greatly to the increasing number of pests. Next, I will discuss the distribution of soybean insect-pests.

Distribution of Soybean Insect-Pests in Japan

Region / Species	Hokkaido	Honshu (Main Island)					Honshu Island	Shikoku Island	Kyushu Island
		Northeast	Kanto (Tokyo)						

(For the bilingual table, see Appendix1)

The symbols in the Appendix table are as follows:
- ◙ species identified in this study as major pests
- ○ species identified in this study as pests of soybean
- \- species that have not been demonstrated to infest soybeans but whose distribution is already known.

Region / Species	Hokkaido	Honshu (Main Island)					Honshu Island	Shikoku Island	Kyushu Island
		Northeast	Kanto (Tokyo)						
See above Appendix	…	…	…	…	…	…	…	…	…
Species considered major pests	12	13	6	10	8	3	10	10	8
Species counted in this study	72	92	48	56	36	34	120	47	66
Soybean insect pests identified in other studies	51						79	68	91
total	123						199	115	157

Notes:
1. Information about the Higashiyama and Hokuriku regions is based primarily on work by Ichiro Kantani, with additional information from Sugiyama/Mochizuki (Hokuriku Nogyo Kenkyu, volume 1, issue 1, 1949). Kantani identified 42 species; Sugiayama and Mochizuki identified 43 species, 14 of which were not included by Kantani, for a total of 56 species.
2. Information about the Kyushu region is based on work by Matsunaga (Kyushu Noshiken Ho, volume 1, issue 1, 1951).
3. The symbols in the table are as follows:

◙ species identified in this study as major pests
○ species identified in this study as pests of soybean
- species that have not been demonstrated to infest soybeans but whose distribution is already known.

As can be seen in the species distribution table, the greatest number of soybean pest species, 199, are found on the main island, which accounts 91% of the total number of pest species; 157 species are found on Kyushu (72%); 123 species on Hokkaido (56%); and 115 species on Shikoku (53%). The numbers of pest species hitherto recognized in each of the regions as causing damage to soybeans are much lower but show a similar tendency: on Hokkaido 58% of the species currently recognized as pests were previously identified as such; on Honshu, 60%; on Shikoku, 59%; on Kyushu, 58%. This is summarized in the following table:

Distribution of Soybean Insect-Pests by Order

Region	Collembola	Orthoptera	Dermaptera	Thysanoptera	Hemiptera	Lepidoptera	Coleoptera	Hymenoptera
Hokkaido	1(1)	9(4)	0	3(1)	23(8)	59(38)	22(14)	0
Honshu	2	18(13)	0	8(7)	53(30)	69(36)	37(24)	1(1)
Shikoku	1	10(2)	0	1	39(20)	30(9)	26(11)	1
Kyushu	2(2)	12(5)	1(11)	3(1)	50(23)	44(15)	33(13)	2(2)
Total	2	19	1	9	55	77	40	2

Numbers in parentheses represent numbers of species previously recognized as soybean pests

Of these species, about 10 species within each region and 30 species nationally should be considered major pests causing significant damage. When investigating the particulars of the species distribution, it is apparent that there are cool-, warm-, and normal-climate characteristics. There are regional differences in the population of specific species and the amount of damage they cause.

Here I would like to present examples and detailed discussion of this point. The following are considered universal pests having wide distribution, *Nezara antennata* SCOTT, *Aphis glycines* MATSUMURA, *Eriococcus sojae* Kuwana, *Grapholitha glycinivorella* MATSUMURA, *Lathronympha phaseoli* MATSUMURA, *Sylepta ruralis* SCOPOLI, *Cifuna locuples* WALKER, *Barathra brassicae* LINNE, *Euxoa segetis* SCHIFFERMULLER, *Chloridea dipsacea* LINNE, *Colia hyale poliograph*US MOTSCHULSKY, *Vanessa cardui* LINNE, *Luperodes menetriasi* FALDERMANN, *Monolepta dichroa* HAROLD, *Paraluperodes suturalis nigrobilineatus* MOTSCHULSKY, *Eugnathus distinctus* ROELOFS, *Serica orientalis* MOTSCHULSKY, *Aserica castanea* ARROW, *Popillia japonica* NEWMAN, *Anomoal rufocuprea* MOTSCHULSKY, *Hylennyia platura* MEIGEN; among these, species that cause significant damage in all regions are *A. glycines* MATSUMURA, *L. phaseoli, C. dipsacea, C. hyale poliographus,L. menetiriasi, P. suturalis nigrobiolineatus,* and *A. rufocuprea; G. glycinivorella, B.* brassicae, and *P. japonica* are destructive pests in the northern regions comprising Hokkaido and the Tohoku (northeastern) region; *Nezara antennata, Sylepta ruralis*, and *Eugnathus distinctus* cause much damage in the southern regions including Shikoku and Kyushu. Some cold-climate pests such as *Eirenephilus longipennis* and *Podisma sp.* are found only in the northern regions encompassing Hokkaido and Tohoku-chiho and not in the southern regions; others such as *Pyrrhia umbra*, which is representative of this group, and *Profetiella soya* also exhibit

characteristics of cold-climate pests and can be highly destructive pests on Hokkaido and the Northeastern region depending on the year, and are found as far south as northern Kanto, Higashiyama, and the *Chugoku* (central) region. *Ophiomyia* sp. also cause damage mostly in the Tohoku region. On the other hand, pests such as *Coptosoma punctissimum, Coptosoma biguttula, Piezodorus rubrofasiatus, Cletus trigonus, Chauliops fallax,* and other *Plataspidae, Etiella zinchenella, Epicanta gorhami*, and the related *Asphondylia* sp., *Ophiomyia* sp., and *Melanagromyza* sp. are found exclusively in the southern areas of Shikoku, Kyushu, and the southeastern end of the Honshu; according to Sugahara, *E. gorhami* can also be found in parts of Fukushima prefecture, and *Asphondylia* sp.in the southern extreme of Miyagi prefecture but in none of the areas further north; it is believed that the northern boundary for these species lies somewhere in Miyagi prefecture on the Pacific coast side and in Akita prefecture on the Japan Sea side. Furthermore, *E. zinchenella* has to date not been observed to cause damage in the Tohoku region; however, the damage gradually increases southwestward from the Kanto region and is significant in all of the Pacific coast regions, Shikoku, and Kyushu. In addition, this species is extremely rare in the Hokuriku region and is known to cause only very little damage in the San'in region. The fact that the distribution of *G. glycinivorella*, which is also a fruit pest, is antipodal (diametrically opposed) to that of *E. zinchenella* is worth noting. As mentioned earlier, *G. glycinivorella* causes damage in Hokkaido, and can cause significant damage in the Tohoku, Kanto, and Higashiyama regions; damaged caused further west is light and outbreaks occur extremely rarely. However, this pest can cause significant damage in the San'in region. In other words, the boundary line, including a zone of overlap, between distribution of the fruit pests *E. zinchenella* and *G. glycinivorella* lies somewhere in the central area of the Kanto region; the former species is found south of the boundary, especially on the Pacific side of Japan, and the latter is found north of the boundary, particularly on the Japan Sea side of the country. The habitat of *L. phaseoli* overlaps that of both these species, with the highest populations being found from central Honshu to Shikoku; in Hokkaido and Kyushu, it is not present in significant numbers and does not require attention as a pest.

Although *Gryllotalpidae* and *Pyransta nubilalis* are found throughout the country, in general they do not cause any damage to speak of; however, in specific locations they have been reported to cause substantial damage. *Clamis bilineata*, which is also found widely, does not generally cause major damage; however, according to Ichitaro Tamura, in the Kanto region, sudden outbreaks occur sporadically which result in significant damage. Another species worth noting for exhibiting regional specificity is *Takenchiella pentagona*. This species was observed early on by Rokuzo Matsumoto, although limited to two mountain villages in Kume-ward of Okayama prefecture; later, it was discovered in small localized areas of Kumamoto, Hyogo and Nara prefectures; and in the present study, Ichiro Kantani observed small localized populations in mountain villages of Takai and Uetakai wards of Nagano prefecture. In addition, Shigeto Itoga and Yoshihiko Yamashita reported that the species infested summer soybeans in localized areas in Satsuma ward of Kagoshima prefecture. The distribution of the above-mentioned species is wide, but they exhibit distinct regional differences. *Sitones japonicus* was observed by Takeo Midono in Shimane prefecture, but as yet this species has not been reported anywhere else.

It is important to note that the poor soybean production in areas of Higashiyama, San'in, Shikoku, and Kyushu, the cause of which could not be previously determined, can largely be attributed to damage by a variety of stink bugs. Among these, the extent of damage caused by *Riptorius clavatus* is conspicuous; damaged caused by *N. antennata*,

Piezodorus rubrofasciatus, *Dolycoris baccarum* is also noteworthy. Of course, the feeding of *Asphondylia* sp. and *Etiella zinckenella* larvae on the beans contributes significantly to yield reduction in these areas.

IV. Pests Classified by Plant Part Attacked

Soybeans are, like many other crops, the target of attack by insect-pests and no part can escape damage. The following table is a classification of soybean insect-pest based on the part of plant affected.

Classification of Soybean Insect-Pests by Plant Part Targeted

Plant part	Collembola	Orthoptera	Dermaptera	Thysanoptera	Hemiptera	Lepidoptera	Coleoptera	Hymeno
roots	1	1	-	-	3	-	8	-
stems	-	7	-	1	49	9	8	-
leaves	2	13	1	8	40	73	35	2
flowers	-	-	-	4	-	1	1	-
pod	-	4	-	-	24	7	-	-
Total	2	19	1	9	55	77	40	2

Note: the plant parts are defined as follows:

1) roots: underground stems, roots, and root nodules
2) stems: above-ground stems and leafstems
3) leaves:cotyledons, newly emerging leaves, and fully developed leaves
4) flowers: buds and flowers
5) seed pods: seedpods and beans

As can be seen in the preceding table, over half of the pests feed on leaves and the proportion of pests that feed on parts other than leaves or stems is substantially lower; furthermore, only a small percentage of pests attack seed pods and beans, and very few attack roots or flowers. The following table presents the major insect-pests of each region by plant part attacked.

Plant Parts Targeted by Major Insect-Pests of Each Region					
region	**Roots and other below-ground parts**	**Stalk and/or leaf stem**	**Leaves**	**Flowers and/or racime**	**Seed pods and/or beans**
Hokkaido	*Anomala rufocuprea*	*Aphis glycines, Luperodes mentiriasi, Profeltiella soya*	*Eirenephilus longipennis, Aphis glycines, Pyrrhia umbra, Barathra brassicae, Chloridae dipsacea, Colias hyale poliographus, Luperodes mentiriasi, Paraluperodes suturalis nigrobilineatus Papilla japonica, Anomala rufocuprea*		*Aphis glycines, Grapholitha glycinivorella, Pyrrhia umbra, Barathra brassicae, Chloridae dipsacea*
Tohoku [Northeast]	*Anomala rufocuprea, Ophyomyia sp.*	*Aphis glycines, Lathronympha phaseoli, Pagria signata, Luperodes mentiriasi, Profeltiella soya*	*Chauliops fallax, Aphis glycines, Sylepta ruralis, Chloridae dipsacea, Pagria signata, Luperodes mentiriasi, Paraluperodes suturalis nigrobilineatus, Anomala rufocuprea*		*Aphis glycines, Grapholitha glycinivorella, Lathronympha phaseoli, Chloridae dipsacea*
Kanto [Central]	*Anomala rufocuprea*		*Sylepta ruralis, Eugnathus distinctus, Aserica castanea, Anomala rufocuprea*		*Etiella zinchenella, Asphondylia sp.*
Higashiyama/ Hokuriku [North-Central]	*Gryllotalpa africana*	*Riptorius clavatus*	*Oxya velox, Riptorius clavauts, Sylepta ruralis, Paraluperodes suturalis nigrobilineatus, Luperodes mentiriasi (Hokuriku), Eugnathus distinctus*		*Riptorius clavatus, Etiella zinchenella (Higashiyama), Asphondylia sp.*
San'in [South-Central Japan Sea Coast]	*Eriococcus sojae*	*Eriococcus sojae, Lathronympha phaseoli, Agrotis ypsilon, Profeltiella soya*	*Lathronympha phaseoli, Agrotis ypsilon, Paraluperodes suturalis nigrobilineatus, Epicauta gorhami*	*Epicauta gorhami*	*Eriococcus sojae, Grapholitha glycinivorella, Lathronympha phaseoli*
Sanyo [		*Riptorius clavatus*	*Riptorius clavatus*		*Riptorius clavatus, Etiella zinchenella, Asphondylia sp.*
Shikoku	*Anomala rufocuprea*	*Dolycors baccarum, Nezara antennata, Piezodorus rubrofasciatus, Riptorius clavatus, Lathronympha phaseoli*	*Nezara antennata, Piezodorus rubrofasciatus, Riptorius clavatus, Lathronympha phaseoli, Sylepta ruralis, Paraluperodes suturalis nigrobilineatus, Anomala rufocuprea*		*Dolycoris baccarum, Nezara antennata, Piezodorus rubrofasciatus, Riptorius clavatus, Lathronympha phaseoli, Etiella zinchenella, Asphondylia sp.*
Kyushu		*Nezara antennata, Riptorius clavatus, Melanagromyza sp.*	*Nezara antennata, Riptorius clavatus, Dichocrocis chlorophanta, Prodenia litura, Paraluperodes suturalis nigrobilineatus*		*Nezara antennata, Riptorius clavatus, Etiella zinchenella, Asphondylia sp.*

In terms of protection against insect pests, many methods should be considered, foremost among them, chemical methods as well as identification and breeding of resistant varieties and improvements in cultural practices. According to previous studies, there were clearly differences between soybean varieties in the damage caused by *A. rufocuprea, G. glycinivorella, Aspohndylia sp., and P. soya*. Analyzing these observations should provide hints for development of insect-pest resistant varieties. In the pursuit of improving soybean yield, immediate attention should be given to entomological study of the major soybean pests in each geographical region.

V. Summary

1. This report combines information from the present study contributed by Kiyoshi Sakurai, Hiroshi Nishijima, Tsuyoshi Kurosawa, Hiro Sugawara, Ichitaro Tamura, Ichiro Kantani, Takeo Midono, Shuji Ishikura, Hajime Suenaga with information from various researchers in the past and summarizes the distribution and damage potential of insect pests of soybean in Japan.
2. 218 species of domestic soybean pests were identified, representing 61 genera and 9 orders. Although in some cases no damage was observed, all insects infesting soybeans were included.
3. The order Lepidoptera comprised the greatest number of soybean insect-pests with over a third, followed by Hemiptera, Coleoptera, Orthoptera, Diptera, and Thysanoptera comprising decreasing numbers; the orders Hymenoptera, Collembola, Dermaptera contributed only 1 or 2 species each.
4. Although there are some insect-pests which feed exclusively on soybean or on members of the pea family, a large number are polyphagous. It is worth noting that included in the list are major pests or rice, tree fruit, and mulberries.
5. The distribution of domestic soybean insect pests is as follows: 199 species on Honshu, 157 species on Kyushu, 129 species on Hokkaido, and 115 species on Shikoku. Among these species, the number which were reported to cause damage in each region were 120 species in Honshu – which entails 92 species in the Tohoku region, 48 in the Kanto region, 56 species in the Higashiyama & Hokuriku, 36 species in the San'in region, and 34 in the Sanyo region – 72 species on Hokkaido, 66 species on Kyushu, and 47 species on Shikoku, which comprise approximately 60% of the species in each region.
6. There were approximately 10 species that should be considered major pests in each region, and a total of 30 species nationwide.
7. From their geographic distribution the species can be categorized as 'cold-climate', 'warm-climate', and 'temperature-insensitive'; while the population and degree of damage caused by each species varies by region: among the major insect-pests *A. glycines, L. phaseoli, C. dipsacea, C. hyale poliographus, Luperodes mentiriasi, Paraluperodes suturalis nigrobilineatus,* and *Anomala rufocuprea* are found throughout the country and are considered 'universal' pests; *Nezara antennata, Sylepta ruralis*, and *Eugnathus distinctus* exhibit similar distribution and can be put in the same class. *Podisma* sp., *Grapholitha glycinivorella, Barathra brassicae, Pyrrhia umbra, Papilla japonica, Profetiella soya,* and *Ophiomyia* sp. represent members of the cold-climate pests. *Coptosoma punctissimum, Piezodorus rubrofasciatus, Riptorius clavatus, Chauliops fallax, Etiella zinchenella*, family *Epicautidae, Asphondylia* sp., *Ophiomyia* sp., and *Melanagromyza* sp. can be classified as warm-

climate pests. In addition, *Clanis bilineata, Takenchiella pentagona Malaise,* and *Sitenes japonicus ROELOFS* show high regional specificity.

8. Poor soybean production areas were known to exist in Higashiyama, Sanyo, Shikoku, and Kyushu, although in most cases, the cause had not been identified. In many cases, poor yield can be traced to damage by bean-attacking pests such as *Asphondyli*a sp. and *Etiella zinchene*lla or sap-sucking pests such as *Riptorius clavatus, Nezara antennata, Dolycoris baccarum,* and *Piezodorus rubrofasciatus*.
9. More than half of the insect-pests cause damage to the leaves, followed by a smaller number that attack stalks and/or leafstems. Still fewer insects cause damage to seed pods and/or beans, and only a very limited number attack roots or flowers.
10. In the pursuit of improving soybean yield, immediate attention should be given to entomological study of the major soybean pests in each geographical region in order to develop and implement protective measures.

[Appendix] Methods of Protection Against the Major Insect-Pests of Soybean

The following are principles of protection against the major insect-pests synthesized from previous research.

… [sections not describing soybean aphid have been excluded]

3. Aphis glycines

(1) Because this insect prefers sunny and dry environments and tends to avoid dark and humid places, intercropping with wheat or corn, or increasing planting density can improve protection.
(2) Emulsions (any of Pyrethrin cinerariaefolium, nicotine, rotenone) are effective; apply two or three times in the early part of an outbreak. DDT is not very effective. BHC (emulsifier or wetting agent 0.02%, powdered BHC 0.5%) is very effective. Washing foliage with pure water on an extremely hot day can also help prevent outbreaks.
(3) Taking care not to accidentally kill predators of A. glycines such as ants and larvae of green lacewings, ladybugs (excluding Epilachna virgintioctopunctata) and hoverflies can be considered a passive and indirect method of protection.

… [sections not describing soybean aphid have been excluded]

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