LOW-COST TECHNOLOGY FOR CONTROLLING SOYBEAN INSECT PESTS IN INDONESIA

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ABSTRACT

Technologies acceptable to farmers in controlling soybean pests were developed through research programs in Indonesia. Rice husk ash was found to be effective against bruchid beetles that attack stored legume seeds. Mixing 1% in weight of the ash in the seeds before storage effectively protects the seeds from pest infestation. Sesbania rostra, a trap crop, was effective in controlling soybean stink bugs. The combination of trap crop and insecticide application increases the effectiveness of pest control. The traditional method of soybean cultivation in Aceh is recommended for controlling Etiella podborers through a cropping system that interrupts the insect's life cycle.

INTRODUCTION

Indonesia imports more than one million metric tons of soybeans each year. Although the local production of soybeans has slightly increased, the consumption of, and demand for, soybeans have also risen over the years. A number of factors affect soybean production in this humid, tropical country. One of them is lower yields due to insect pests. Improving the methods of pest control is necessary to obtain higher yields.

In the 1980s, soybean pests were mainly controlled through the use of chemical insecticides. Our surveys conducted on farmers in major soybean production areas in this country showed that the frequency of insecticide application was usually five or six times per year (ranging from a minimum of three to a maximum of ten). During my stay as a JICA expert from 1988 to 1994, doing research into soybean pests at the Bogor Research Institute for Food Crops in West Java, Indonesia, our urgent objective was to reduce the frequency of insecticide applications to less than three times a year, and to develop alternative low-input technology for soybean farmers.

The three major subjects of my research are as follows:

- Control of bruchid beetles in stored soybeans, using rice husk ash;
- Control of stink bugs using trap crops such as *Sesbania rostrata;*
- Control of podborers by the traditional cropping system.

RICE HUSK ASH TO PROTECT SOYBEAN SEEDS FROM BRUCHID BEETLES

Stored soybean seeds are sometimes infested by Graham bean beetles (*Callosobruchus analis* (F) (Col.). Experiments using ash to control pests in stored beans began in 1988. The idea originated with farmers in Java, who mixed ash with their stored soybean seeds, and also in Japan where volcanic ash had caused damage to silkworms.

Experiments and Results

Three kinds of natural substances, namely, rice husk ash, wood ash and lime, were mixed with soybean seeds at three ratios (0.25, 0.5, and 1.0 by weight) and in five replications. Pairs of adult beetles were then released in test cages for one month, two

Keywords: bruchid beetles, *Callosobruchus* spp., cropping system, Etiella podborers, rice husk ash, soybean, stink bugs, trap crops

months and three months respectively. The materials used are inexpensive, and easily obtained anywhere in Indonesia. The results are summarized as follows.

Persistence of Lethal Effect

Adult mortality was checked with five replications at 0-5 and 90-95 days after release. The results are shown in Table 1. Evidently, rice husk ash had a marked effect on the mortality rate. Mixtures with 0.5% and 1% gave 100% mortality which continued for three months after treatment. The lethal effect of wood ash did not last as long as that of rice husk ash. Treatment with lime was less effective than with the other substances.

Prevention of Oviposition

Soybean seeds were mixed with each of the three substances at a rate of 1.0% (by weight). The adult beetles were released in each treatment, immediately after and one month after treatment, and the number of their eggs deposited on soybean-seed were finally counted. Fig. 1 shows that the number of deposited eggs was the smallest in seeds treated with rice husk ash (only 10-20 eggs in 500g of soybean seed). One hundred to 160 eggs were deposited on seeds treated with wood ash, and even more eggs were laid on lime-treated seeds.

Suppression of Population Growth

The total numbers of adult beetles that emerged in the first and the second generations are shown in Fig. 2. Evidently, rice husk ash showed the highest suppression effect and the smallest number of adults emerged, followed by wood ash and lime in that order.

Prevention of Seed Damage

To what extent were the treatments ultimately able to control pest damage? Fig. 2 shows that the damage to stored beans treated with rice husk ash was the least severe, at only 1.4%, compared with 26.6% in untreated beans. These figures demonstrate that rice husk ash is highly effective in controlling *C. analis* beetles.

Effectiveness Against Other Bruchid Beetles

According to our experiments (unpublished), 1% of rice husk was also effective in controlling the adzuki bean weevil, *Callosobruchus chinensis* L., in mungbean. The results obtained were nearly the same as with *C. analis i*n soybean.

How Rice Husk Ash Controls Bruchid

Table 1. Effect of rice husk ash, wood ash and lime against adult mortality (%) of *Callosobruchus analis*, when the amendments were mixed with soybeans at a rate of 1% (by weight)

Substances tested	Mixing rate (%)	No. days after treament			
		0 - 5	30 - 35	60 - 65	90 - 95
Rice husk ash	0.25	100.0	79.0	50.3	27.3
	0.50	100.0	100.0	100.0	100.0
	1.00	100.0	100.0	100.0	100.0
Wood ash	0.25	100.0	31.0	13.0	5.5
	0.50	100.0	59.6	33.4	24.7
	1.00	100.0	93.0	88.8	79.2
Lime	0.25	12.5	3.0	2.0	1.0
	0.50	23.7	7.0	4.0	3.2
	1.00	36.6	15.0	13.1	8.6
Control		0.0	0,0	0,0	0,0

Source: Suyono and Naito 1991

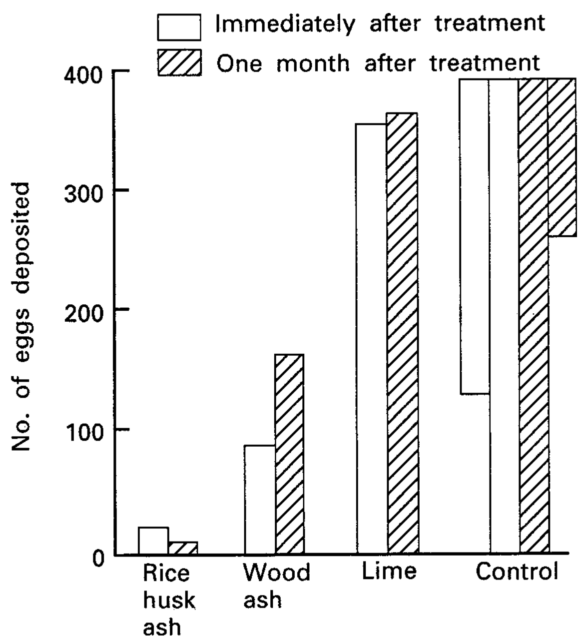

Fig. 1. Effect of rice husk ash, wood ash and lime against oviposition of *Callosobruchus analis*, when the amendments are mixed with soybeans at a rate of 1% (by weight).

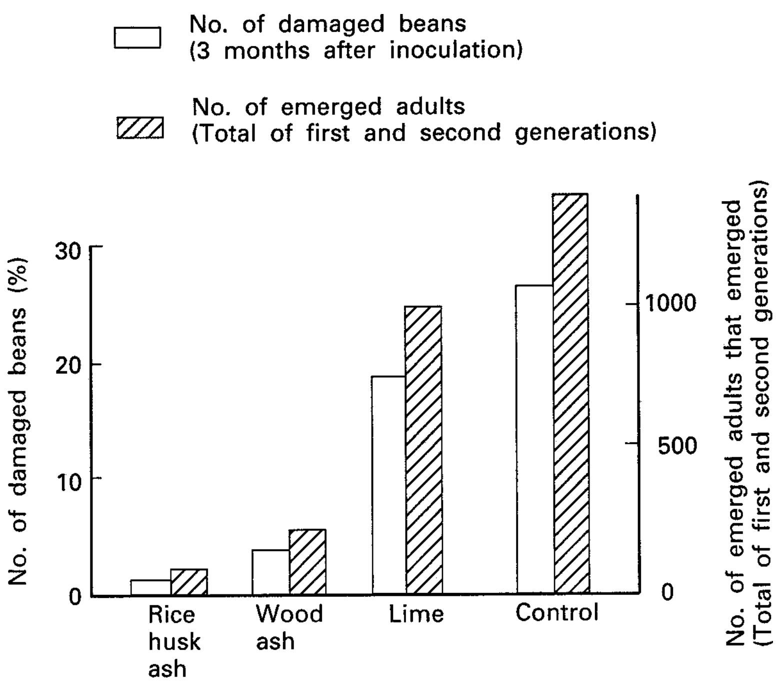

Fig. 2. Effect of rice husk ash, wood ash and lime on infestation and reproduction of *Callosobruchus analis*

Beetles

The lethal action of rice husk ash on bruchid beetles has not yet been fully analyzed. However, there are some interesting indications. The main ingredient of rice husk ash is silica (SiO_2), accounting for 96% of the total content. The ash has almost the same composition as diatomaceous earth (Table 2). One type of diatomaceous earth, commercially named "Insect", is effective in controlling pests of stored grain. The high silica content must have a lethal effect on insects.

Rice husk ash also includes a large amount of needle-like particles (Plate 1) that are probably derived from the setae covering the outer surface of the rice hull. These needle-like particles may trigger a physical reaction on the skin of insects, and the resulting physical disturbance may help cause their death. It is also believed that inert substances generally cause a loss of body moisture.

How to Apply the Rice Husk Ash

The rice husk ash should be spread by hand over well-dried soybean seeds stored in a can with a capacity of 6 - 18 liters. The ash should be gently mixed with the seed by hand, and the lid placed tightly on the can. The can should be kept in a cool, dark place. Fresh, dry ash should be used, at a rate of around 1% of the seed weight, for the control of *C. analis*.

I have observed that some farmers store soybean seeds with rice husk ash in central Java. The soybean seeds were mixed with ash and stored in an empty can (Naito 1984). However, the farmers were not aware of the effect of rice husk ash on grain legume pests. The farmers put ash only on the surface of the seeds. As the adult beetles crawl over the seeds, they come into contact with the ash. Some effect can be expected even without mixing. The cans used for storing seeds and rice husk ash can easily be obtained in any rural or suburban area. Ash is customarily widely used in daily life in Indonesia, for example when in washing and polishing dishes and eating utensils.

In South Sulawesi, near Ujunpandang, in 1993, we observed that farmers had begun to use rice husk ash when storing soybean seeds. The technique was based on our research results, and the farmers obtained the information from the Maros Research Institute for Food Crops and the rural agricultural extension service.

Matsumoto (1987) has also reported that some Indonesian farmers used rice husk ash in storing soybean seeds. In those cases, seeds were mixed with ash at a ratio of 10% of seed weight in plastic bags or cans. Good results were obtained, and the rice husk ash promoted the drying of grain.

There are also some reports on the traditional use of wood ash to control bruchid beetles attacking cowpea seeds in Africa, including South Africa and Cameroon (Wolfson, J.L. *et al.* 1991; Apuuli, J.K.K. and Vilet, M.H. 1996). The use of paddy husk ash against five beetles infesting stored grains was studied, and was found effective at a rate of 1-2.5% (by weight) (Tee 1981).

Table 2. Chemical composition (%) of tested natural substances (Suyono, Gusti and Naito 1991)

Chemical component	Rice husk ash	Wood ash	Lime	Insecto*
SiO_2	96.01	60.00	35.57	97.81
CaO	0.30	23.50	60.51	0.50
MgO	0.28	3.32	3.67	0.24
Na_2O	0.06	0.16	0.04	0.03
Fe_2O_3	0.08	0.19	0.01	0.07
Al_2O_3	0.96	1.04	0.07	0.25
K_2O	0.96	9.60	0.01	0.02
P_2O_5	0.88	2.34	0.01	0.02

* Formulation of diatomaceous earth

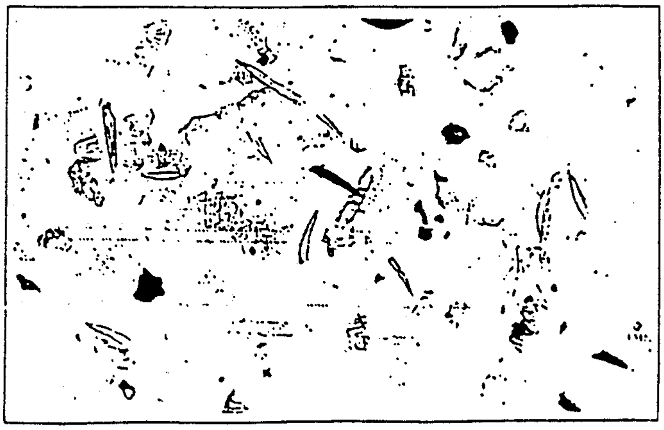

Plate 1. Microscopic appearances of rice husk ash

Rice Husk Ash as an Agent for Absorbing Moisture in Stored Soybean Seeds

Rice husk ash is not only useful for pest control, but also for moisture absorption. According to Mikoshiba, the most important element in maintaining the germination ability of stored soybean seeds in the tropics is moisture content. Seeds must be kept dry, with a moisture content of less than 8% (Mikoshiba 1997). Because fresh rice husk ash kept under dry conditions usually has less than 4% moisture content, it can be used to dehydrate the stored seeds. The use of rice husk ash enables farmers to store soybean and mungbean on a small scale and for a low cost. Airtight containers should be used, and the rice husk ash should be fully dried.

CONTROLLING SOYBEAN STINK BUGS WITH TRAP CROPS

In Indonesia, growing soybeans are often infested by various species of stink bugs, particularly *Nezara viridula* L., *Piezodorus hibneri* Gumelin and *Riptortus liniaris* (L). These stink bugs sometimes cause severe damage to young seeds ripening in the pod. To prevent damage, a simple method using trap crops was tested. The concept of using trap crops is based on the fact that stink bugs are usually found on long beans (*Vigna unguiculata cylindrica*) in Indonesia.

Selection of Trap Crops

First, we screened some trap crops suitable for stink bugs at the Bogor Research Institute for Food Crops, West Java in 1989 and 1990. Among the candidate plants were *Sesbania rostrata,* mungbean (*Vigna radiatus)*, long bean *(Vigna unguiculata cylindrica)*, cowpea *(Vigna sinensis)*, and some early maturing cultivars of soybean *(Glycine max)* and pigeon pea (*Cajanus indicus*). Pigeon pea was observed to attract not only these stink bugs, but also other soybean insect pests.

S. rostrata was selected as the most suitable trap crop. It possesses the characteristics of a good trap crop. It is taller than soybean, and since it takes longer to mature, it can also attract stink bugs over a longer period. Adults of *N. viridula,* a dominant species in Bogor, are very much attracted to this crop. Because *S. rostrata* is not a suitable food plant for nymphal development, it reduces the opportunity for stink bugs to reproduce.

Control of Soybean Stink Bugs Using the Trap Crop *S. rostrata*

Field trials were conducted on a semi-large scale in an area of about 1-3 ha in Bogor, West Java, and Mojosari, East Java. *S. rostrata* was planted two weeks before soybean was sown, in two rows along two borders of the plot.

The experiment conducted in Bogor showed that the bug population was obviously lower in plots with a trap crop than in those without one (Table 3 Fig. 3 and Fig. 4). At first, the bugs emigrated into the trap crop from surrounding areas when *S. rostrata* had passed the flowering stage. Their main population remained on the trap crop, although some of them moved onto the soybean plants from time to time. Consequently, the population of the bugs on the soybean plants decreased by 1/6 to 1/10. Seed damage caused by the bugs fell by 17.5% in the trap-crop plot. In contrast, 42.7% of seeds in the plot without the trap crop were seriously damaged (Table 4). This is because adult bugs had direct access to the soybean plants.

According to the data we gathered in Mojosari (Wedanimbi *et al.* 1994), the effective control area of Sesbania on stink bugs is about 15m from the crop. When the trap crop is planted in a soybean field, it is usually better to put it on opposite sides of the field i.e., south and north, or east and west. If the soybean field is large, the Sesbania should be planted in rows about 30m apart.

How to Use Trap Crops

The use of trap crops to control insect pests of soybean and cotton began in the United States in the 1970s. The traditional method of using trap crops to control insect pests received some attention, but had limited success. Trap crops were used to attract and accumulate pest insects to prevent them be from infesting major crops.

Essentially, trap crops must occupy a small space and must be planted earlier than the main crop. They must also be highly attractive to the insect pest. If the population of insect pests on the trap crop exceeds the threshold level, it should be controlled with insecticide.

This type of control must also be as economical as alternative control methods. In other respects it is highly acceptable, because it fits in with existing farming practices and reduces the amount of insecticide used. This results in minimum adverse effects on natural enemies, predators and parasitoids on the main crop. Insecticides can increase the efficiency of trap crops. Depending on the situation, insecticide may be applied on the trap crop alone, or can also be applied to the soybean plants, but at a lower rate.

Principles of Using a Trap Crop

Table 3. *Nezara viridula* population on soybean with and without trap crop, and on trap crop.

Plot	No. adults	No. nymphs
With trap crop	27.0	99.0
Without trap crop	154.7	941.0
On the trap crop	300.3	107.0

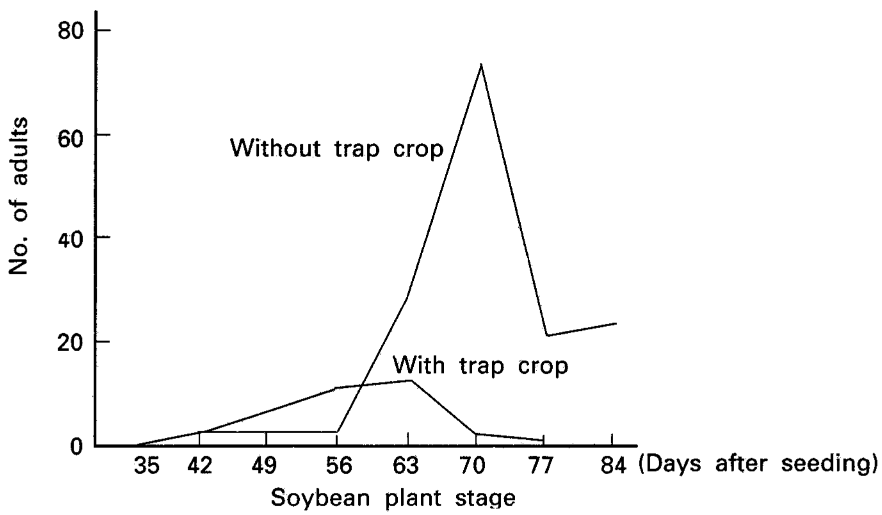

Fig. 3. Adult population of *Nezara viridula* on soybean with and without trap crop

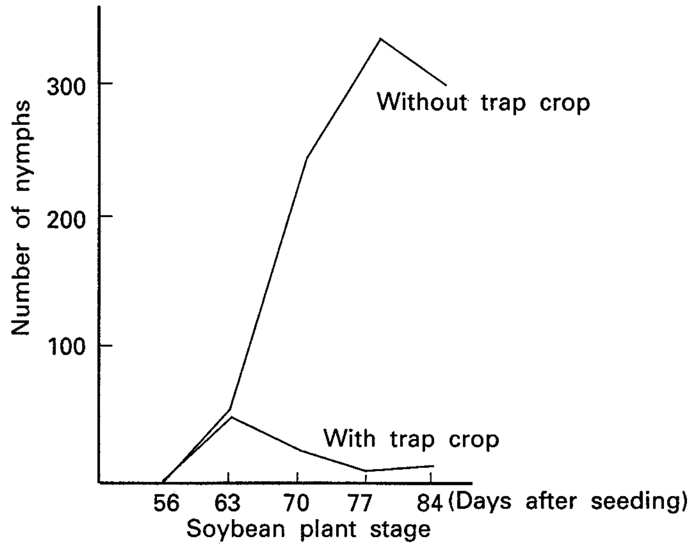

Fig. 4. Nymph population of *Nezara viridula* on soybean with and without trap crop

Table 4. Comparison of damage caused by stink bugs on soybeans planted with and without trap crops

Plot	No. of grains surveyed	No. of grains damaged	Damage (%)
With trap crop	3166.3	552.7	17.5
Without trap crop	4460.3	1903.7	42.7

- A trap crop must be attractive to the target insect pests. At the same time, a trap crop must be a useful plant.
- The period during which the trap crop attracts the target insect pests should start earlier and last longer than that of the main crop.
- If the insect pest population on the trap crop is high, the pests should be controlled with insecticides or other control methods, such as the destruction of the trap crops. Otherwise, the pests on the trap crops might reproduce.

Combination of Trap Crops and Target

Insect Pests

There are a number of successful examples demonstrating the use of trap crops for controlling legume insect pests. Early planted soybean or early maturing soybean, cowpea and *S. rostrata* have been used to control stink bugs, (*N. viridula* etc.), on soybeans (Newson and Herzog 1977; IITA Research Highlights 1981; McPherson and Newson 1984; Kobayashi 1987; Wedanimbi and Naito 1988; Naito 1996). Snap bean (*Phaseolus vulgaris*) has been used to control Mexican bean beetle (*Epilachna varivestis*) on lima bean and soybean (Rechard 1977). Long bean, (*Vigna anguiculata cylindrica*) is sometimes used to control soybean stink bugs in Japan (Kikuchi and Naito, unpublished). According to our observations in Japan, long bean is an excellent trap crop to attract stink bugs such as *Plautia stali, Nezara antennata, Piezodorus hybneri* and *Riptortus* *clavatus*. However, this crop is a climbing plant and its period of attraction is short. Hence, long bean is not the perfect trap crop.

Layout of Trap Crops

Sesbania is usually planted on two opposite sides of a soybean field. This is because the concentration of stink bugs in soybean fields is conspicuously higher around the edges of the field (see Fig. 5). Trap crops can also be planted as intercrops with a main crop. This method is usually applied to control cotton boll worm, *Heliothis armigera,* in cotton, maize and sorghum.

A third alternative is a block design, usually set in a large area. This method is mainly applied to fields of more than 100 ha to control soybean stink bugs in the USA (McPherson and Newson 1984).

What percentage of the total target area should be allocated for the trap crop? It is hard to give a definite figure, because there are so many different types of trap crop. However, 5-10% might be the standard. In the case of soybean stink bugs in the USA, from about 5%, to a maximum of 15 % of the soybean acreage planted is recommended for trap crops (Recommendation of Louisiana Extension Service, USA).

CONTROLLING ETIELLA PODBORERS ON SOYBEAN BY THE TRADITIONAL CROPPING SYSTEM

Factor Analysis

The damage caused by Etiella podborers is much higher in Indonesia than in most other countries. The pod damage ratio in most soybean production areas exceeds 50% over the dry season. However, in certain areas of North Aceh in Sumatra, where three crops of soybean are cultivated each year, it is known that the level of damage is consistently very low, at around 1%. Surveys were carried out to find what factors affected low populations in these areas, compared to the high populations in the Tempe lake area in South Sulawesi (Fig. 6).

Field Survey

Aceh, Kecamaan Peudada and Jeumpa were the main soybean production areas chosen. Three surveys were carried out, one in April - May 1989, the second in May 1990 and the third in October 1992. Damage to pods by Etiella podborers was assessed at 12 sites in 1989 and at 9 sites in 1992. The Tempe lake area in South Sulawesi was chosen as the second survey area, partly because it has been designated as a priority soybean production area in Indonesia. Three surveys were done, the first in March 1991, the second in February 1993 and the

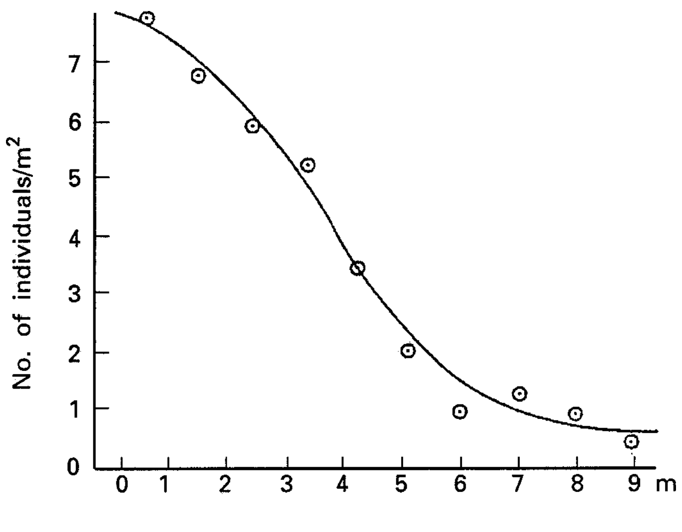

Fig. 5. Population density of stink bugs on soybean field (Kobayashi and Cosenza 1987)

third in July 1993.

We investigated the soybean growing conditions, the cropping system, the occurrence of insect pests, soil conditions, and the climate. We counted the number of soybean pods damaged by podborers in samples of 10 hills per soybean field. Soybean yield and meteorological data were collected directly through interviews with farmers, the agricultural extension service offices and local government offices (Dinas Pertanian Tanaman Pangan).

Results of Survey

Level of Damage

The percentage of soybean pods damaged by podborers in Aceh (Peudada and Jeumpa) was very low – 0.8% in 1989, just under 1% in 1990, and 1.1% in 1992 (Table 5). Other noctuid leaffeeders such as *Heliothis* and Spodoptera are not usually a threat to soybean in these areas. Damage by sucking bugs was not very high, except in a few soybean fields where weeds were abundant.

Few farmers sprayed insecticides against soybean pests in Peudada and Jeumpa in 1993 (Table 8). Only one-fifth of the farmers sprayed insecticides one or two times against defoliators.

In contrast, the Tempe lake area in Sulawesi had a lot of pest and disease problems. The damage caused by Etiella podborers reached 65% in May 1991, and 59.6% in February 1993 (Table 6 and Table 7). The population of podborers was high, and other soybean insect pests were also abundant. Insecticides were applied frequently, 2-10 times/field. Most farmers sprayed insecticides once a week (Table 8).

Level of Yield

Yields were significantly higher in the Peudada and Jeumpa areas of Aceh than in other soybean producing parts of Indonesia. The first survey (April - May 1989), found that average yields were 1.7 - 2.0 mt/ha. The highest yield was nearly 3.0 mt/ha. The third survey found average yields of about 2.0 mt/ha. These were nearly double the national average in Indonesia, which in 1990 was around 1.1 - 1.2 mt/ha. The system of soybean cultivation in this area is very unusual. Soybean is cropped throughout the year, and has been continuously cultivated in the same fields for more than 10 years.

Similar soil conditions were found in the Peudada and Jeumpa area of Aceh and in the Tempe Lake area of south Sulawesi. Soils were grumusols, alluvial soils and rendzina, all of which can be considered suitable for soybean production.

The yields of soybean in the Tempe lake area would not be so low if the damage caused by insect pests was not so severe. Samples indicated a yield rate of 1.5 mt/ha (1.0 - 2.0 mt/ha) in March 1990. However, the yield was not stable. The

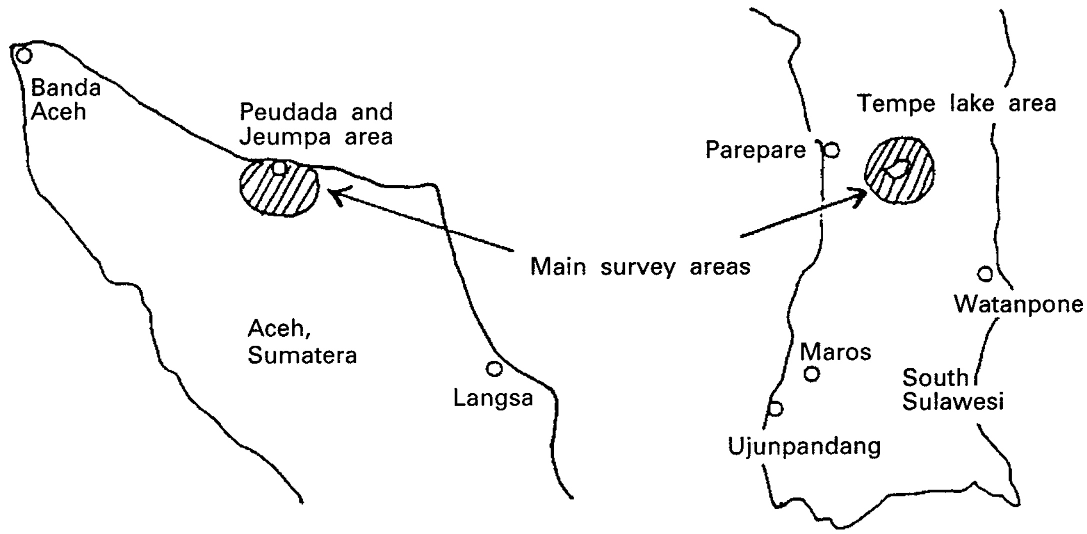

Fig. 6. Two areas surveyed in Aceh province, Sumatra and in South Sulawesi province

quantity and quality were sometimes low because of diseases and pests, particularly podborers.

Reasons for Differences in Podborer Density

Cropping System and Planting Time

As previously mentioned, the Peudada and Jeumpa areas of Aceh had high soybean yields and a low occurrence of pests and diseases, particularly podborers. Why is the population of podborers low in these areas, in spite of continuous soybean cultivation?

It seems that the life cycle of podborers is shortened by the soybean cropping system, in which host plants are absent two or three times a year. Soybean is planted over a large area of about 3,000 – 4,000 ha within a few days. After the soybean is harvested, a large areas has no soybean at all for a period of one month or more, while alternate host plants such as long bean are found only in a restricted area. Mungbean is sometimes planted near the soybean field, but is usually not a host plant for podborers in these areas. The major reason for the slight occurrence of podborers is the disruption of their life cycle caused by the lack of food between crops (Fig. 7).

How do Aceh farmers manage to sow soybean over such a large area at the same time? Their system combines good traditional practices and the recommendation of the Aceh Provincial Government regarding sowing time. When it is time to sow, farmers meet in the village and hold special ceremonies. The village leader then instructs the farmers to prepare their land and soybean seeds. As soon as the

Table 5. Soybean pods damaged by *Etiella* podborers in Peudada and Jeumpa area in Aceh

1989			1992	
Sites		Pod damaged %	Sites	Pod damaged %
Smalongan	0.2	Cot Loreng	0	
Peudada	No. 1	1.8	Blang Bladeh No. 1	0
Peudada	No. 2	1.5	Blang Bladeh No. 1	0
Peudada	No. 3	0.5	Meunasah Tengah	7.6
Jili	No. 1	0.6	Pulo Ara	0.6
Jili	No. 2	0.5	Pulo Lawang	0.6
Jili	No. 3	0.0	Blang Bati	0.0
Jeumpa	No. 1	1.0	Blang Ketumba	1.0
Jeumpa	No. 2	0.0	Abuek Usong	0.0
Jeumpa	No. 3	1.0	Abeuk Budi	0.0
Peusorgan	No. 1	1.0		
Peusorgan	No. 2			
Average		0.8		1.1

Table 6. Soybean pods damaged by *Etiella* podborers in Tempe lake area, South Sulawesi in 1991

Places	Pod damage %
Tanrutodeng	82.1
Meueang Pago No. 1	50.0
Meueang Pago No. 2	54.5
Average	62.2

Table 7. Soybean pods damaged by *Etiella* podborers in Tempe lake area, South Sulawesi in 1993

Places	Soybean pod damage (%)	
Near Tempe lake area		
Ongkoe	26.3	
Lepangang	66.1	59.6 (Average)
Macero	84.5	
Bone area		
Ponpanue	54.5	
Usa	32.6	
Mattanete Banuang	9.9	
Toro	16.1	
Lompu	30.9	22.0 (Average)
Walenyeng	20.8	
Pattimpa	0.0	
Cani Sidenreng	43.8	
Selli	1.9	
Tungke	9.2	
Jeneponto area		
Tolo Utara No. 1	42.6	36.7 (Average)
Tolo Utara No. 2	30.8	

Table 8. Comparison of insecticide applications on soybean in Aceh and South Sulawesi

Aceh (1992)		South Sulawesi (1993)	
Survey sites	Insecticide applications	survey sites	Insecticide applications
Peudada area		Wajo (Tempe lake area)	
Cot loreng	None	Sidenreng	5 - 6 times
Meunasah Tenga	1 - 2 times	Onkoe	5 - 6 times
Pulo Ara No. 1	None	Leppangang No. 1	7 - 10 times
Pulo Ara No. 2	1 time	Madero	Every week
Blang Bati	None	Jeneponto area	
Bulo Lawang	None	Tolo Utara No. 1	10 times
Jeumpa area		Tolo Utara No. 2	Every week
Blang Bladah	None	Bone area	
Abeuk	None	Ponpanue	2 - 3 times
Balang Ketumba	None	Lompu	3 times
Abeuk Budi	None	Warenreng	3 times
		Patimpa	4 times

rains begin, most farmers go out into fields before sunrise to sow soybean.

Soybean planting times in Peudada or Jeumpa areas were also recommended in advance by the Provincial Agricultural Office, as follows:

First planting 25 February – 15 March
Second planting 25 June – 15 July
Third planting 25 October – 15 November

The production system in the Tempe lake area was quite different. Soybean and other legumes were cultivated throughout the year, except during the middle and late rainy season. Common cropping patterns were rice-soybean-soybean or rice-soybean-mungbean. The planting time of soybean varied, according to the condition of the farmers' fields. Consequently, both soybean and mungbean were always present in the area. Furthermore, alternate hosts of podborers were abundant in the area. For instance, *Crotalaria* and *Tephrosia*, which are popular host plants, were cultivated as green manure. Longbean, a possible alternative host, is also often cultivated near farmers' houses.

The high population of podborers in the Tempe lake area was due to the fact that the insect can repeat its life cycle continuously thoughout the year (Fig. 8).

Soybean Cultivars

The soybean variety is not considered to be an important factor in the occurrence of podborer, because all soybean cultivars can become infested. However, there are some differences between the cultivars in Aceh and those in South Sulawesi. In Aceh, more than ten cultivars were cultivated, including Kipas Putih, Kipas Merah, Lombo Putih, Ek Manok, Penang Lutong, Wilis, etc. In South Sulawesi, on the other hand, only two soybean varieties were grown, Wilis and Orba. The coexistence of varied cultivars, as in Aceh, may reduce the risk of damage by pests and diseases.

Control of Podborers in Other Cropping Systems

Crop damage from podborers is less if soybean is cultivated after the cultivation of rice, because the population of podborers is low during the rice cultivation period. In places such as Majalenka, Cianjur and Sulade in West Java, the infestation by podborers can be eradicated if soybean is cultivated after rice and if host plants are not abundant. These areas are fundamentally safe against podborer infestation. However, if the soybean crops are sown at different times, as in the case of some cultivars which are planted two weeks later than the early cultivars, podborers would still be able to repeat a generation in both the early cultivars and in the soybean planted later, even if there is a previous crop of rice.

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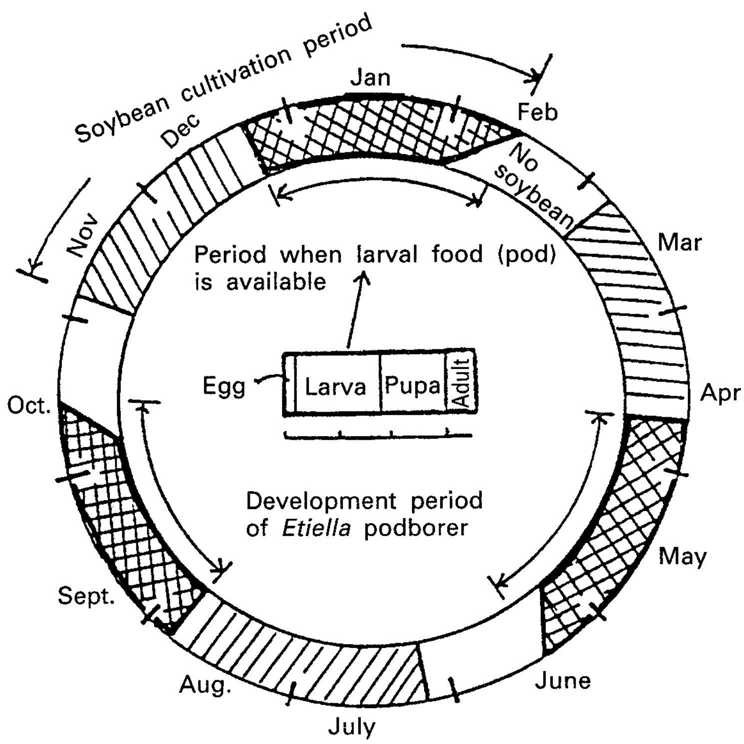

Fig. 7. Schematic illustration of the relationship between soybean cropping system and life cycle of *Etiella* podborer in Peudada and Jeumia, Aceh

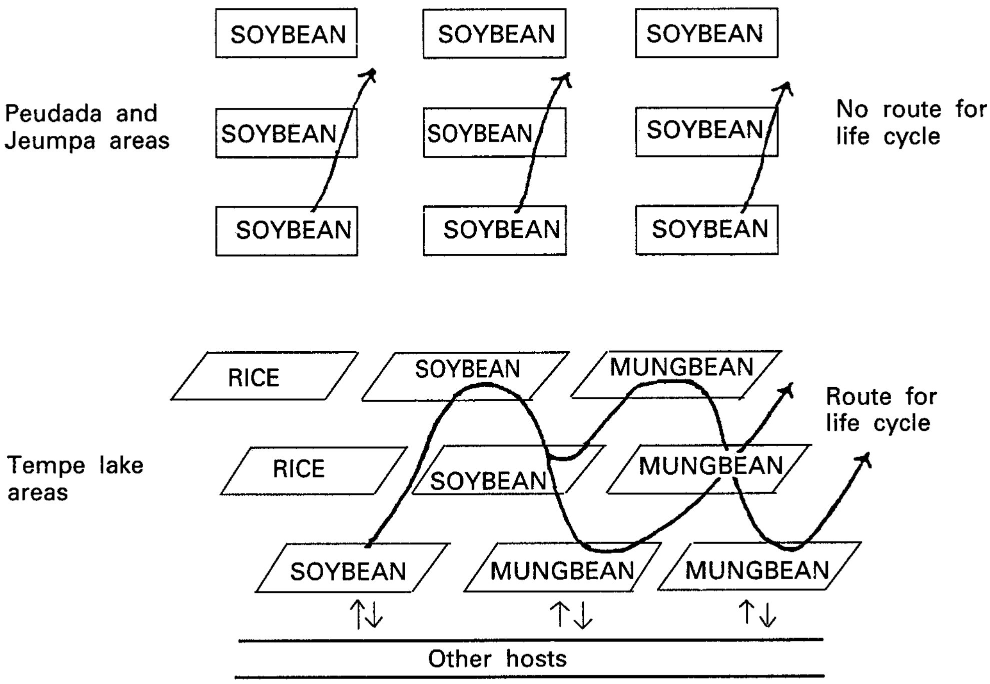

Fig. 8. Comparison of life cycle of *Etiella* podborer's in the soybean fields in the Peudada and Jeumpa area, Aceh, and the Tempe lake area, South Sulawesi.

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