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Fluctuation of Soybean Aphids and Epidemic of Soybean Mosaic Virus in Summer Soybeans in Nanjing Area

Weiming LI and Zuqin PU

(Section of Plant Pathology, Nanjing Agricultural University, Nanjing)

Abstract: During 1987-1988, yellow pan traps were used to monitor soybean mosaic virus (SMV) vector activity in summer soybean fields in the Nanjing area. Because of different climatic and environmental conditions, the phenology and alate density varied considerably. Aphids colonizing soybean were *Aphis glycines*, and few *A. craccivora* and *A. gossypii* were also found on soybean plants. Out of 29 species trapped in the two-year experiments, *A. citricola*, *A. craccivora*, *A. glycines*, *A. gossypii*, *Lipaphis erysimi*, *Myzus persicae*, *Rhopalosiphum maidis*, *Schizaphis graminum* and *Therioaphis trifolii* were known as SMV vectors. *Aphis glycines* was the main vector which spread SMV in summer soybean fields. In 1987, the migration peak of aphids occurred in the early soybean growing stage, the peak of disease incidence appeared two weeks later, and an increase rate of disease incidence was positively correlated with aphid density ($P<0.01$) In 1988, however, aphids had a migration peak after soybeans bloomed and there was no linear correlation between the number of migrating aphids and the epidemic of SMV ($P>0.05$).
Key words soybean, vector, aphid, soybean mosaic virus (SMV), epidemic.

Soybean is an important agricultural crop. Viral disease is one of the vital factors that affect soybean yields. Of over 30 viral diseases worldwide, soybean mosaic virus (SMV) is the most widely distributed and is the most serious virus (Irwin and Schultz, 1981). Thus, understanding the dynamic of SMV epidemics is very important to monitoring and control this virus. A number of studies on the SMV epidemics have been conducted in other countries (Irwin and Goodman, 1981), but few studies have been done on this virus in China (Zhang *et al.,* 1986; Chen *et al.,* 1988) and the SMV epidemics are unknown in the summer soybeans along the Yangtz River. We carried out a preliminary study on the fluctuation of soybean aphids and the SMV epidemics in summer soybeans in 1987-1988.

Materials and Methods

Experiments were conducted at the Jingpu Farm of Nanjing Agricultural University in 1987-1988. Variety 1138-2 was tested and sown on June 29th, 1987. Variety Suxie 1 was used and sown on June 21st in 1988. Both varieties are susceptible to SMV by mechanical transmission in the laboratory.

1. Survey of disease incidence spread by soybean seeds

After the first pair of true leaves of soybean spread, five sites were chosen randomly in the field. One hundred plants were surveyed at each site and disease incidence was recorded.

2. Yellow pan trapping

Four yellow pan traps with water were set up after soybean seeds were sown. The height of yellow pans was the same as soybean plants and adjusted as plants grew. At 8:00 in the morning, aphids in the pans were collected, counted and identified.

3. Survey of aphid species and density on soybean plants

After the first pair of true leaves spread, aphids were surveyed at the designed sites and plants once a week. In 1987, 25 plants were checked each time, and aphid species and numbers were recorded. In 1988, 60 plants were surveyed each time, and aphid species and numbers on one leaf of the top, middle and lower part of each plant were recorded.

4. Survey of disease incidence in the fields

Five sites were chosen in the field. In 1987, 50 plants were designed at each site, while 100 plants were designed in 1988. After seed-borne infested plants were checked and labeled, disease incidence was surveyed every week and diseased plants were labeled.

Results and Discussion

1. **Aphid species migrating and colonizing fields and its population dynamics**

In 1987, migrating aphids of summer soybeans peaked in late July. Many species were found in the survey. A total of 999 individuals were clooected and 24 species were collected. In addition to *Aphis glycines*, a high fraction of aphids were *A. gossypii*. The high incidence of *A. gossypii* may be due to the high complexity crops around the experimental field, which was close to cotton fields and weedy.

In early July 1988, there was continued high temperature, which is really rare in Nanjing. The average temperature in July was 2.3℃ higher than 1987. Aphid migration was delayed until mid to late August. Because crops around the experimental field were relatively simple and only soybeans were planted within the areas of 1000 m around the experimental field that was less weedy, 17 aphid species were trapped and *Aphis glycines* was the dominant species. This was despite the fact that we collected 5415 aphids in 1988 (far more than in 1987).

Experiment results above showed that migrating aphid species, number and population dynamics in the summer soybeans were distinctly different between years, and climatic and environmental conditions (Fig 1).

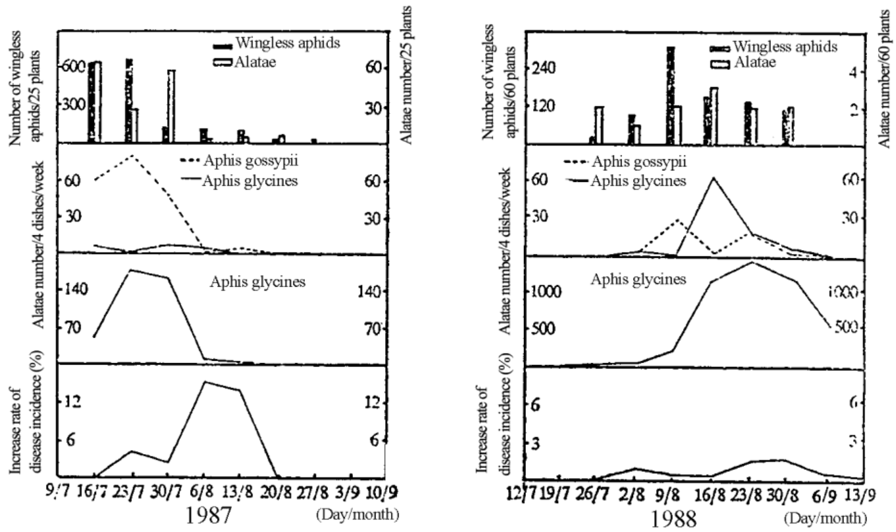

Fig 1 Aphid population dynamics and incidence of SMV

In Fig 1, wingless aphids peaked on July 23rd, and alatae peaked on July 16th and 30th in 1987. In 1988, wingless aphids peaked on August 9th and alatae peaked on July 26th and August 16th. Aphid peaks in both years were basically synchronized with the migration peak of alatae.

In both years, *Aphis glycines* was the dominant species colonizing soybeans. Few *A. craccivora* and *A. gossypii* were found on soybeans. No other species were found on soybeans.

Of 29 aphid species collected by yellow pans in two years, 9 species were potential SMV vectors. Soybean aphids accounted for 40.34% and 94.80% of all aphids in 1987 and 1988, respectively (Table 1). Based on these results, the main vector of SMV in the summer soybeans slightly differs from that in the spring soybeans (Chen *et al*., 1988).

Table 1 Aphid species and number trapped by yellow pans

Aphid species	1987		1988	
	Aphid number	Percentage (%)	Aphid number	Percentage (%)
Aphis citricola	7	0.66	1	0.02
A. craccivora	426	40.34	4863	94.80
A. gossypii	216	20.45	58	1.13
A. glycines	24	2.27	92	1.79
Lipaphis erysimi	1	0.09	3	0.06
Myzus persicae	7	0.66	1	0.02
Rhopalosiphum maidis	12	1.14	2	0.04
Schizaphis graminum	12	1.14	2	0.04
Therioaphis trifolii	1	0.09	-	-

2. Relationship between aphid population dynamics and SMV

Disease incidence of seed-borne infested plants was 1.8% and 0.2% in 1987 and 1988, respectively. Disease incidence of plants in the field was 39.2% and 7% in the last survey during soybean growing season.

In 1987, about two weeks after aphid migration peak, incidence of SMV peaked in the field. In 1988, a small peak also appeared after the aphid migration peak (Fig 1).

Assuming the latent period of virus is 2 weeks, we analyzed the linear correlation between the rate of SMV incidence and aphid density (see Table 2).

Table 2 Linear regression of aphid density (x) and rate (y) of SMV incidence

Analyzing items		1987		1988
		r	Model	r
Migrating aphid	Total aphids	0.981**	$y = 0.038x - 0.681$	-0.103
	Aphis craccivora	0.409		0.514
	Aphis glycines	0.995**	$y = 0.087x - 0.523$	-0.064
	Aphis gossypii	0.832*	$y = 0.169x - 0.154$	0.337
	Vectors of SMV	0.969**	$y = 5.837x - 0.925$	0.046
Colonized aphid	Apterous aphids	0.499		0.630
	Alatae	0.564		0.563

Note: n = 7, $r_{0.05} = 0.754$, $r_{0.01} = 0.874$. Translator reorganized the table (in red) and added the second row (in blue).

In 1987, the summer soybeans started to bloom on August 13th and the aphid migration peak appeared before the flowering stage. Yellow pans trapped a total of 674 aphids that were potential vectors of SMV. Although the aphid number was not huge, the aphid density was significantly linearly correlated to the rate of disease incidence (P>0.01). In 1988, soybean bloom began on August 6th and the aphid migration peak appeared after flowering. Yellow pans collected a total of 5,035 aphids that were potential vectors of SMV. The aphid density was much higher than that in 1987. However, the aphid density was not linearly correlated to the incidence of SMV (P>0.05).

Results of two-year experiments preliminarily showed that SMV relies mainly on the development stage of aphid vector. If migrating aphids peak at the early stage of soybean development, small numbers of migrating aphids may cause an epidemic of SMV. If the aphid migration peak is after soybean bloom, even a large number of aphids will not be able to cause an epidemic of SMV.

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