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Aphid Flight Activity and Epidemiology of Soybean Mosaic Virus in Spring Planted Soybeans

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Abstract Experiments were carried out in areas of Yangzhou, Nanjing and Zhenjiang in Jiangtsu Province in 1979-1984. Results showed that alate aphids were the major vectors of SMV transmission and apterous aphids had no relation to the epidemic of SMV in the field. Alate aphids were collected by yellow-pan water traps and apterous aphids were quantified by observations on soybean plants. Predominant species of alate aphids transmitting SMV were *Myzus persicae*, *Aphis craccivora* and *Rhopalosiphum pseudobrassicae*. Species, number of aphids, and landing date varied considerably in differents area and from year to year.

During the aphid flight activity period, the younger the soybean plants, the more severe the disease. Non-persistent insecticides used against aphids in soybean fields provided no significant effect on SMV disease control.
Key words Aphids, Spring soybean, Soybean Mosaic Virus, Field epidemic

1 Introduction

Viruses are an important disease to the production of soybean. Soybean viruses are usually severe on spring soybeans in Jiangsu Province. The investigation in 1979 showed that disease incidence on susceptible variety was generally more than 50%, sometimes even up to 95%. Yields and quality of the infected plants were significantly decreased. The bean-pod number, bean number and bean weight of infected plant were noticeably lower than those of healthy plants. Previous research has demonstrated that virus disease on soybean was mainly caused by soybean mosaic virus (SMV). The primary source of spread was disease-carrying seeds while aphid vectors also spread the disease. Many species of aphids, varying by region, could transmit SMV. This paper summarizes the research carried out on spring soybeans from 1979 to 1984 in Yangzhou, Nanjing and Jurong.

2 Materials and methods

2.1 Survey on alate aphids

Based on the attraction of aphids towards the yellow color, yellow pans of 25-30cm diameter and 5cm depth were filled with water and placed in the field for trapping. The placement of the pan was raised with the growth of the plants, maintaining a constant position 30-40cm above the soybean plants. Each pan was set in the southwest, southeast and north parts of the test field, respectively. Each day the collected aphids were removed at 5:30-6:00, and then identified and counted. The trapping period lasted from mid-April to mid-July.

2.2 Survey of the apterous aphids

The number of apterous aphids were counted by surveying the fixed plants in soybean fields from seedling onwards, once every two days. Simultaneously, we surveyed the incidence of disease on different soybean varieties in the field.

2.3 Caging test in small plots

Seeds from healthy soybean plants of variety No.1138-2 and Taixing varieties were sown in 7 plots respectively and covered with netting. Two replicates were designed in each plot. After April 20, every 10 days the net of one plot was opened to maintain the plants for 10 days under natural conditions. While this plot was re-covered and sprayed with insecticide to kill aphids, the nets of another plot were opened. This action was carried out to the last plot. Beside the cages there were grown plants inoculated with the virus. Analysis was carried out by comparing the condition of infected plants in and outside of cages during different periods, and the number of the alate aphids collected in yellow pans. In addition, the impact of the occurrence of aphids on the incidence of disease of soybean sown in different times was investigated.

2.4 Inoculation test of aphids

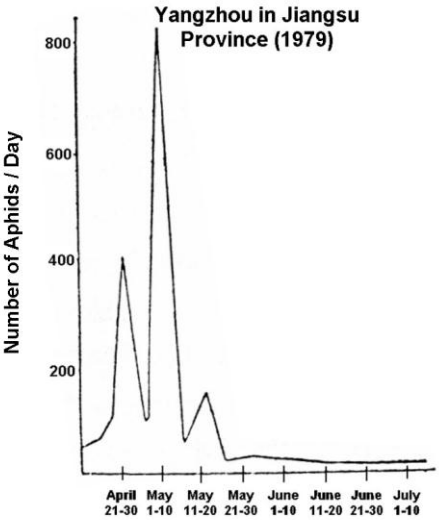
This test was carried out by conventional methods. The source of SMV virus was identified and maintained on the 1138-2 variety.

2.5 Insecticide trials

Seeds of three varieties (1138-2,18-6 and 493-1) were treated with the systemic insecticide, 3% Furan granule and then sown immediately, but the seed without treatment was the control. The survey was carried out twice on both the number of aphids and incidence of disease on the treated plants.

3 Results

3.1 Migration of the alate aphids



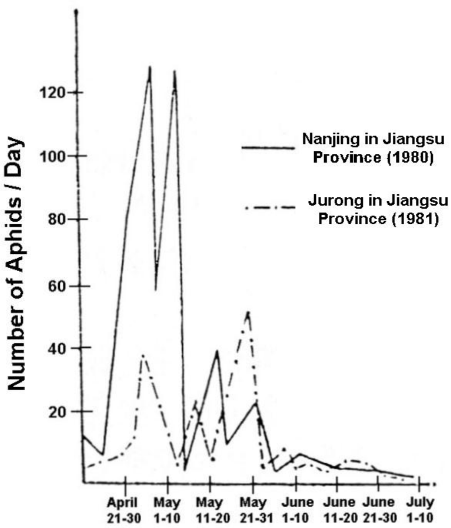


Fig.1 Number of alate aphids trapped by yellow pan in different regions and years

The results of trapping alate aphids by yellow pan (Fig. 1) show that alate aphids can always be obtained by trapping from late April to early July. The migration of alate aphids peaked mainly in May, but the peak date and aphid populations varied significantly in different areas and from year to year. In 1979 and 1980, the peak of flight occurred earlier than usual, especially in late April to 15th May when the number of trapped aphids populations reached its peak. In 1984, the migration peak was 10 days or so later than in 1979, and the greatest number of aphid populations appeared to be after this peak, with the greatest peak in late May. The number of trapped alate aphids varied considerably from year to year, i.e., in 1979, the greatest average number each pan was more than 800 per day, but in 1980, the greatest only reached 120.

3.2 The impact of number of alate aphids on incidence of disease

After seedling emergence, every 10 days the infestation situation was surveyed in the plots with opened nets at different times. For example, test results of Jurong in 1984 showed that the difference of net-opening date led to a significantly different degree of incidence of disease. Comparing the severe degree of disease to the migrating dynamics of alate aphids, it can be found that the greater the number of insect populations captured by the yellow-pan during exposure period, the higher the incidence of disease later in this plot, such as the fourth plot. A lower incidence of disease was present in the plot where lower aphid populations were trapped, and no disease was observed in the control plot where nets were never opened. The above results were also demonstrated by the test at Yangzhou in 1979. The regression equation between the number of migrating aphids and the incidence of disease was as follows:

$$Y=0.168 + 0.00078X \qquad (r=0.882)$$

Y = Disease severity index; X = the number of the alate aphids.

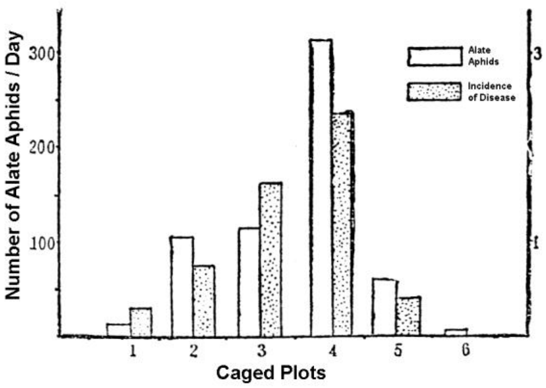


Fig.2 The effect of date of cage opening and number of immigrating aphids on the incidence of disease

3.3 The relationship between the dynamics of the apetrous aphids and the severity of disease

The dynamics of the apetrous aphids were investigated on soybean plants in at a fixed site. The results showed that the peak period of apetrous aphids lasted from 20th May to 20th June in 1979 in Yangzhou, and the average number of aphids reached more than 318 on each plant. In three plots where the cage nets were opened during the peak period, the incidences of disease were 51.9%, 33.9%, 11.1% respectively. In the plots where nets were opened before the peak population occurred, although there were only few numbers of apterous aphids, a higher incidence of disease was still produced .The incidence of disease approximated 100 percent in the plots with nets opened in early May. The field incidence of disease reached its peak before May 15th. Correlation analysis also indicated that the number of alate aphids on the plants had no relation to the occurrence and epidemics of SMV (r= - 0.46).

3.4 impact of the growth stage of soybean on the incidence of disease during migrating peak period

The test of sowing in different periods was done in Jurong in 1984. The results suggested that the incidence of SMV disease varied with different growth stages of soybean. During SMV-transmitting peaks of aphids, the smaller the plant, the more severe the disease later. For example, as the seedlings of Taixing black soybean sown on 7th May encountered the flight peaks of apeterous aphids, 24 percent of the incidence of disease was found on June 20th. But to every stage of the plants sown before late April, the incidence of disease was mostly less than 10 percent, for the plants had grown and resistance to disease was enhanced by the peak time of aphid flight. In addition, in the plot sown on May28th, although the soybean plants were very young, the incidence of disease was only 2 percent or so. This is because flight peaks had passed, leading to less transmitting-virus vectors when the seedling emerged. The trends of disease severity of soybean varieties sown at different periods in natural fields were consistent with the trends found in test plots.

3.5 Predominant aphid species transmitting to soybean mosaic disease

Many species of alate aphids were collected by yellow-pan water traps. In both Nanjing in 1980 and Jurong in 1984, the trapped aphids were identified, and the commonly occurring species were *Myzus persicae*, *Aphis glycines*, *Rhopalosiphum pseudobrassicae* and *Aphis craccivora* and so on at more than 10 species. Species, number and emergence date of aphids varied in different areas and from year to year.

Figure 3 shows that the predominant species were *M. persicae* and *R. pseudobrassicae*, with less *A. craccivora* and none of *A. glycines* before late May 1980 in Nanjing. Although *A. glycines* became the dominant species after mid-June, its number was noticeably less than that of *M. persicae* or *R. pseudobrassicae* trapped during the earlier period. Figure 3 also shows that among the collected aphids in Jurong in 1984, *M. persicae* and *A. glycines* were the primary species, secondly *A. gossypii, A. lambersiand* so on, and the trapped number was noticeably fewer than those in Nangjing. The test by artificial inoculation demonstrated that except for the wheat aphid, *Macrosiphum granarium*, five species of aphids, such as *M. persicae*, *R. pseudobrassicae*, *A. gossypii*, *Aphis craccivora*, and *A. glycines*, all were vectors for SMV disease. It was obvious that although the species and occurrence date of aphids varied in different areas, most of them were able to transmit SMV. Therefore it was more reasonable to analyze the total number of the trapped aphids in the investigation.

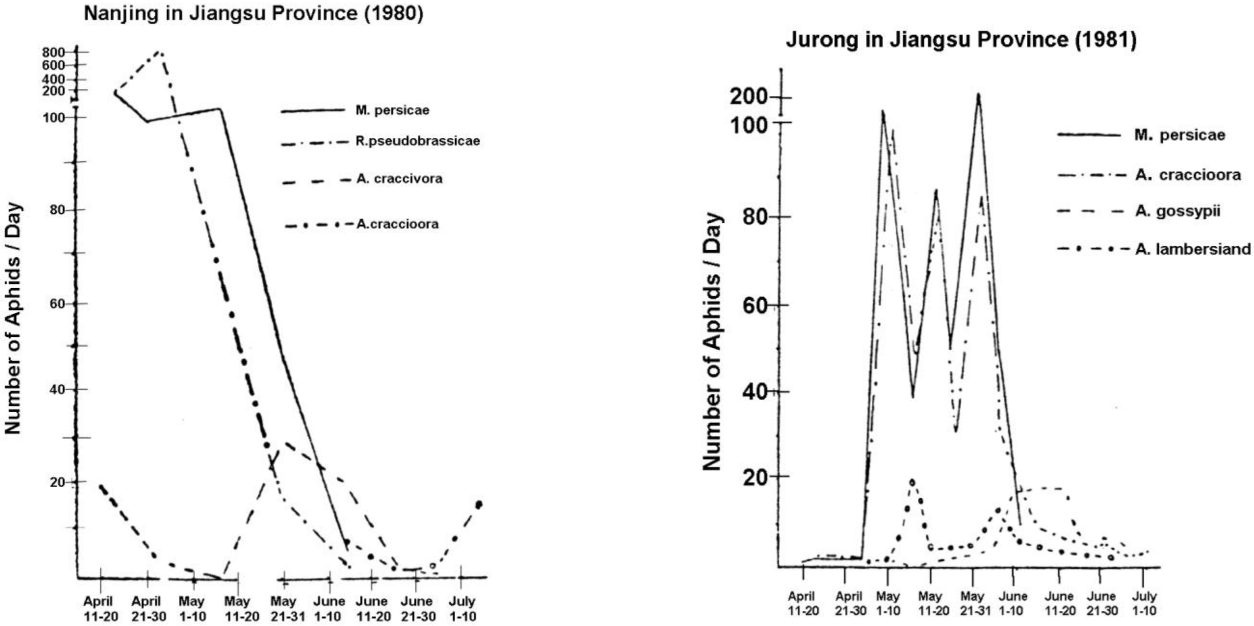


Fig.3 The occurring date and number of different species of the alate aphids

3.6 Affection of controlling aphids by insecticides on the effective prevention of disease

3% Furan granules were used to treat soybean seeds, the effect of which was investigated on June 10th 1979. It showed that the number of aphids was zero after treatment, but the aphids occurred in all untreated areas with varying numbers. The same results were obtained on July 10th. It was apparent that dressing seeds by 3% Furan granules to control aphids was remarkably effective. However, no evidence indicated that there was a lower incidence of disease in the treated plots than in untreated plots (see Appendix table).

Although the insecticides were good for controlling aphids, it was of no effect in preventing SMV disease, and the incidence of disease between the treated and untreated appeared not to be significantly different (a =0.05). Therefore it can be concluded that a satisfactory effect to prevent disease will not be obtained by only using conventional pesticides.

Appendix table The incidence of disease of seeds treated with Furan granule

Varieties soybean	Treated areas		Control areas	
	Average aphids number/10 plants	Incidence of diseas (%)	Average aphids number/10 plants	Incidence of diseas (%)
1138-2	0	25.41	105	25.36
18-6	0	14.21	46	12.04
49-1	0	1087	51	12.31

4 DISCUSS

4.1 Comparing the trapping of alate aphids by yellow-pan with the test in the plot caged with netting, it can be found that there is a positive correlation between the migrating number of alate aphids and the epidemics of the SMV (r=0.882). Usually, the peak of field SMV disease emerged after the migrating peak of the alate aphids 10 days later. The apterous aphids had no relation to the occurrence and epidemics of the disease. Because the wingless aphids only stayed on the same plant or moved within a narrow range despite a rapid reproductive ability, the alate aphids rather then the apterous aphids determined the occurrence period and the epidemic degree of the SMV disease. Therefore the occurrence quantity and period of alate aphids can be considered as the basis to forecast the occurrence and epidemics of SMV disease in the field.

4.2 During the migrating peak of the alate aphids, the younger the soybean plants, the more susceptible to infestation and the more severe the disease. So, if the seedling stage could avoid encountering the migrating peaks of aphids, it would be possible to reduce the SMV occurrence. Generally, sowing in advance is likely to decrease the damage of SMV disease. However, the migration of aphids varied in different areas and from year to year. In addition, the migration date and occurrence quantity were affected by all kinds of factors. Therefore, further studies are needed for exactly forecasting the migration date and occurrence quantity of aphids.

4.3 During the planting period of the spring soybean, there are many species of migrating aphids. Although the occurrance date and quantity of alate aphids *Myzus persicae* is mostly consistent in different areas and from year to year, variation is present in different species of the alate aphids. Many aphids that are the vectors of SMV disease in the field certainly do not damage the soybean and, by contrast, the important vectors usually are dispersing aphids.

4.4 Using 3% Furan granules to treat seeds is proven a very useful measure to control aphids, but no difference is found between the treated and control in the incidence of disease. This may be due to its non-persistent manner of transmission. Before the aphids were killed by pesticides, they had succeeded in transmitting the virus by probe feeding during the migrating and landing period, so prevention of disease could not be achieved with killing aphids by pesticides. It appears that methods of avoiding aphid migration into fields and arresting their feeding might have an effect on preventing disease.

References

1 Chen, Y.X. et al., The identity of soybean mosaic virus. Journal of Plant Pathology 1981; 11:31-35

2 Hill,J.H., B.S.Lucas, H.I.Benner, et al., Factors associated with the epidemiology of soybean mosaic virus in Iowa. Phytopathology 1980; 70(6):536-547

3 Irwin,M.E. and G.A.Schultz, Soybean mosaic virus. FAO Plant Protection Bulletin 1981; 29(3/4):41-54