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# Control Threshold of Soybean Aphids

Cunluan LIN, Zhenshan XUN, Lingtang LI, Yanpeng WANG and Guangxin ZHANG
(Jining Institute of Agricultural Sciences, Jining, Shandong)

**Abstract:** Relationship between aphid density during flowering season and soybean yield was surveyed in 1998-1990. Based on the 3-year study, we proposed the control thresholds of soybean aphids for different levels of soybean yield.

**Key words:** Soybean field, aphid, control threshold.

The soybean aphid, *Aphis glycines* is a major pest in the soybean field. It has recently developed in a broad area and caused serious damage. Usually it is necessary to control soybean aphids during the soybean growing seasons. Some control thresholds of soybean aphids had been proposed previously, e.g. 3,000 aphids per soybean plant (Yue 1990) and 10% percent of curled leaves of Tiefeng 3 and 8% of Liaodou 3 (He *et al*. 1991). These indices were based on the specific situation and soybean production conditions in Northeast China and they were suitable solely in this area. However, the development and damage of soybean aphids in North China are different from those in Northeast China. For example, aphids develop from early July to early-mid September, aphids slightly infest in the seedling stage, and aphids build up significantly and give rise to serious damage in the blooming stage. Soybean aphids need to be controlled several times if above control indices were used in North China, and it will not be suitable in terms of economical benefit. To solve this problem, we studied the control indices in 1988-1990 and proposed a new control index for soybean aphids.

## Materials and Methods

In 1989, experiments were performed in the soybean field. In the seedling stage, flat fields with even fertility and seedling condition were chosen as experiment plots. Row and plant spaces were the same. Plants were labeled individually. The control plot was kept pest-free by pesticide, and soybean aphids developed naturally in the treated plots. Soybean aphids on each plant were counted in the early flower stage. Aphid density was recorded every 7 d thereafter. Soybeans were harvested and surveyed individually. Plant height, effective pod numbers, seed numbers, weight per 100 seeds and seed weight per plant were recorded and soybean yield was calculated correspondently.

In 1990, experiment plots were designed prior to sowing. Plot size was 1 $m^2$. Plant space was 0.25 m. Six levels of aphid density were designed i.e., 0, 65, 150, 600, 1,250 and 1,750 aphids on each plant. Each experiment had 3 replicates. Plants were labeled individually. In the early blooming stage, aphid numbers were adjusted accordingly based on aphid density on each plant, and then aphid density was recorded. Surveys were conducted every 5 d thereafter, and selected aphid density was kept until aphid population decreased in the field. Plants were surveyed individually after harvest, and soybean yield was calculated in each plot.

## Results

### 1. Relationship between soybean aphid density and soybean yield

Table 1 shows the relationship between average aphid density per 100 plants and soybean yield in 1989 and 1990.

Table 1 Relationship between aphid density and percentage of soybean yield loss

| Year | Treatment | Average aphid density per 100 plants | Average yield per plant (g) | Yield (kg/ha) | Yield loss (%) |
|---|---|---|---|---|---|
| 1989 | 1 | CK | 14.17 | 3,189 | - |
| | 2 | 5,300 | 13.92 | 3,132 | 1.79 |
| | 3 | 13,450 | 13.31 | 2,995.5 | 6.07 |
| | 4 | 37,257 | 12.45 | 2,802 | 12.14 |
| | 5 | 75,175 | 11.87 | 2,671.5 | 16.23 |
| | 6 | 114,270 | 10.73 | 2,415 | 24.27 |
| 1989 | 1 | CK | 22.30 | 3,570 | - |
| | 2 | 6,404 | 21.69 | 472.5 | 2.73 |
| | 3 | 15,800 | 20.45 | 3,273 | 8.32 |
| | 4 | 80,156 | 19.06 | 3,051 | 14.54 |
| | 5 | 105,581 | 18.43 | 2,950.5 | 17.35 |
| | 6 | 142,700 | 17.55 | 2,809.5 | 21.30 |

Regression equation of yield loss percentage and average aphid density per 100 plants are shown as follows:

1989: $y = 1.8652 + 0.0002006\ x$ (1)

$n = 6$, $r = 0.9815$, $p < 0.01$

1990: $y = 2.6941 + 0.0001371\ x$ (2)

$n = 6$, $r = 0.9691$, $p < 0.01$

Combined equation of 2-year data:

$y = 3.1799 + 0.0001519\ x$ (3)

$n = 11$, $r = 0.9463$, $p < 0.001$

Soybean aphid density per 100 plants has a significantly positive correlation with the percentage of soybean yield loss.

### 2. Determination of control threshold

Control threshold is dynamic and determined by the production level in the field. Lower control threshold will be proposed if higher production, lower economic threshold and stricter control on pests are required.

Economic threshold level (L) is determined by crop yield ($P_n$), price of crop produce ($P_r$), control cost (C, including chemicals, labor, appliances, etc.), cost effect (E) and economic parameter (F i.e., the ratio of economic and social effect to cost after finishing a project). It can be expressed as:

$$L\ (\%) = C \times F \times 100 / P_n \times P_r \times E$$

Control threshold of soybean aphids refers to soybean aphid density when the loss caused by soybean aphids in the field is equal to economic threshold (L). If L = y (yield loss percentage), aphid density will be the control threshold under economic threshold level (L).

Because $y = a + bx$, if $y = L$, then $C \times F \times 100 / P_n \times P_r \times E = a + bx$, and

$x = C \times F \times 100 / b \times P_n \times P_r \times E - a/b$ (4)

Based on the present soybean production situation, C = 2.0 yuan, $P_r$ = 1.50 yuan/kg, E = 90%, and F = 4. The control thresholds of soybean aphids are calculated from equations (3) and (4) (see Table 2).

Table 2 Control threshold of aphids for different soybean yield levels

| Yield (kg/ha) | 1,500 | 1,875 | 2,250 | 2,625 |
|---|---|---|---|---|
| Economic threshold (%) | 5.93 | 4.74 | 3.95 | 3.39 |
| Control threshold (aphids per 100 plants) | 18.90 | 10,286 | 5,082 | 1,366 |

The soybean yield currently in China is about 1,500-2,250 kg/ha. The correspondent control threshold of soybean aphids will be 18,090-5,082. In favor of convenient use in the practice, we suggested average 10,000 aphids per 100 plants in the blooming stage as control threshold. The control threshold can be adjusted accordingly in the area with various production levels.

## Discussion

From our survey on the population dynamic of aphids in Southwest Shandong in 1988-1990, aphid population was small in the seedling stage and usually it needed no control. Aphids increased gradually from later seedling to early flower, and kept the exponent increase for 10-15 d. Aphid number reached 60,000-120,000 at peak. Flowers and pods develop in this key period, therefore, aphid infestation will cause severe yield loss. It is necessary to control aphids in this period in terms of their development. On the basis of aphid development and damage, we studied the relationship between aphid density in the blooming and podding stages and soybean yield, and proposed the control threshold of soybean aphids.

Soybean aphids have a patchy distribution pattern in the field (Liu 1986). To insure the aphid control efficiency, sufficient sampling sites are important in the field survey.

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