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A Study on the Damage and Economic Threshold of the Soybean Aphid at the Seedling Stage

Wang Xibei[1], Fang Yihao[1], Lin Shizhong[1], Zhang Lirong[1], Wang Huadi[2]

[1] Plant Protection Station of Kaihua County, Zhejiang Province, China

[2] Crops Insects and Diseases Forecasting Station of Zhijiang Province, China

Abstract: Both plot inoculation experiments and field pest scouting at the seedling stage indicated that soybean yield losses were closely related to the number of soybean aphids and the proportion of plants colonized by soybean aphids. The main factors affecting the soybean yield were decrease in plant height and number of pods and seeds, owing to injury by soybean aphids at the seedling stage. Under existing production conditions, the economic injury level was 3.36%. The control threshold was 500 soybean aphids per 100 plants, with 35% of plants colonized by soybean aphids.

Key Words: soybean aphid, seedling stage, damage losses, economic threshold

Soybean aphid is a predominant pest at the soybean seedling stage in Zhejiang Province, causing especially serious damage to summer soybeans. From 1992 to 1993, we examined damage by soybean aphids at the seedling stage in order to quantify economic damage and identifying the economic threshold, to provide a scientific basis for forecasting and pest biological control.

1. Materials and methods

On June 27th, we planted the local soybean "Bawang" in cropland treated with similar fertilization. The plant density was 40x25 cm, one soybean per cluster. We designed thirty plots, each with an area of 2m^2 and with gaps of 0.5 m between plots.

Inoculation experiments began at the first node stage: seven treatments were 5, 10, 50, 100, 220 aphids per plant, separately, having plants without insects as the control. Each treatment was repeated trice, with all plots were randomly arranged. After

inoculation, ten plants from each plot were labeled and the number of soybean aphids was counted every fifth day until the budding stage (July 28th), after which all plants were treated with pesticides. The control plot was treated with pesticides several times to make assure plants in the control plot without damage by soybean aphids. After full maturity of soybeans was reached, the production of plots was examined separately; ten soybeans per plot were sampled. The economic characteristics of soybeans such as plant height, pods per plant, number of seeds, and weight of 100 seeds were examined.

For the nine plots without inoculation, the proportion of plants colonized by aphids and number of soybean aphids per plant were counted. At the fully mature stage, yield of plots was examined. The relationship between the proportion of plants colonized by aphids and production damage was analyzed.

2. Results and Discussion

2.1 Damage of soybean aphid at the seedling stage

It was indicated that damage by soybean aphid increased with the increasing number of soybean aphids per plant (Table 1). When the mean number of soybean aphids ranged from 5 to 220, the yield decreased from 2.73% to 51.8%. The relationships between number of soybean aphids per plant and damage was analyzed using Curve Regression, with the mean number of soybean aphids per plant in each plot as X_1 and damage as Y_1. The simulated equation was as follows: Y_1=-18.0751+13.324 ln$x$, r_1=0.9955**.

Table 1 The density of soybean aphids and damage at the seedling stage

No. of soybean per plant	Product of plot (kg)	Product Per Mau (kg)	Loss of product according to control	Proportions of loss of product
5	0.564	188	5.3	2.73
10	0.513	170.9	22.4	11.59
50	0.363	121.1	72.2	37.35
100	0.321	107.1	86.2	44.59
150	0.303	101	92.3	47.75
220	0.28	93.2	100.1	51.78
CK	0.58	193.3		

2.2 The relationship between proportion of plants colonized by soybean aphid and yield loss at the seedling stage of soybean.

The proportion of plants colonized by soybean aphid was closely related to yield loss. When the mean number of soybean aphid was under ten and the proportion of plants colonized by soybean aphid under 3.5%, yield loss was below 4.0%. When the mean number of soybean aphids was greater than 50 and the proportion of plants colonized by

soybean aphid up to 7.6 to 10.6%, yield loss was from 4.1% to 5.2%. This indicates that in addition to the number of soybean aphids per plant, the yield loss at the seedling stage also correlated to the proportion of plants colonized by soybean aphids.

2.3 The main economic characteristics affecting yield of soybean

After injury by soybean aphids at the seedling stage, the economic characteristics such as plant height, pods per plant, seeds per plant, seeds per pod and weight per 100 seeds were examined (Table 2). Compared with the control, for soybeans colonized with 5 to 220 aphids per plant, plant height decreased from 5.65% to 29.2%; the number of pods per plant decreased from 4.16% to 54.8%; number of seeds per plant decreased from 1.48% to 50.77%; number of seeds per pod increased slightly; and weight of 100 seeds varied little. According to statistical analysis, the number of soybean aphids per plant (X) was negatively correlated to plant height (Y_2), $r_2 = -0.8492^{**}$; the number of soybean aphids per plant was also negatively correlated to number of plots (Y_3) and the number of seeds per plant (Y_4), $r_3 = -0.8761^{**}$, $r_4 = -0.8839^{**}$. There was no significant correlation between number of soybean aphids per plant and soybean hundredweight. This indicates that hypo-genesis of plants at the seedling stage from the damage of soybean aphids, which lead to lowering of plant height, and the decrease in of number of pods and seeds per plant were the main factors affecting yields of soybean.

Table 2 The influence of crop injury by soybean aphids upon yields at the seedling stage

No.of soybean aphids/plant	Plant height (cm)	Mean # pods	No.of seeds per plant	No. of seeds per plot	Hundredweight of soybean	Total dry weight
5	53.4	110.6	186.6	1.69	15.1	282
10	53.2	107.8	169.8	1.58	15.1	256.4
50	45.4	71.4	124	1.74	14.65	181.7
100	39.9	63.4	107.8	1.7	14.9	160.7
150	40.3	55.2	99	1.79	15.3	151.5
220	40.5	54.1	93.3	1.72	14.98	139.8
CK	56.6	115.4	189.5	1.62	15.3	289.9

2.4 Economic Threshold

2.4.1 Identification of Economic Injury Level (EIL)

Economic injury level is the most important basis for design of an economic threshold of soybean aphids. The following equation could express economic injury level of soybean aphids:

$$EIL = \frac{C.F}{P.E.Y} \times 100$$

Where Y is soybean yield; P is the price of soybean; E is the efficiency of pest control; C is the cost of pest control; F is factors of benefits.

Integration of economic, ecological and social efficiency, F was assigned as two with the principle which benefits were once more than costs of pest control. According to experiments of soybean aphid control, we used 70 ml 40% Omethoate to control soybean aphids, having an efficiency of soybean aphid control of approximately 95%. The costs were 6.2 Yuan/667m^2; the price of soybean (P) was 2.2 Yuan/kg and mean soybean yield each season was 150kg/667m^2. Consequently, the economic injury level was 3.96%.

2.4.2 Economic Threshold

On the basis of economic injury level and the equation of the relationship between number of soybean aphids at the seedling stage and yield loss, the economic threshold was 523 soybean aphids per 100 plants.

2.4.3 pest control index

According to the experimental and statistical analysis, the relationship between the number of soybean aphids at the seedling stage and yield loss, and the systematic investigation of field fluctuations of soybean aphids over two years, we recommend a control threshold of 550 soybean aphids per 100 plants and 35% of plants colonized by soybean aphids.

The occurrence of soybean aphids was influenced by environmental factors such as climate, the growth and stages of plants, and natural enemies. Therefore, the field experiments were so variable that many of them need to perfected further.

3. References

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