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Effects of Soybean Aphid, *Aphis glycines* on Soybean Growth and Yield

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Abstract: Population dynamics of the soybean aphid, *Aphis glycines* and its effects on soybean growth and yield were surveyed in 1989-1990. Experiments were conducted in the naturally infested plots and in the treated plots using 10% enhanced Dimethoate. In 1989, soybean aphids in the untreated plots developed earlier and increased rapidly. Aphid density per 100 plants on June 15th was over 10,000, and the rapid development period was over 40 d. But aphids in 1990 developed slightly later with a shorter development period. Soybeans in the untreated plots significantly displayed the symptoms of distorted leaves, shorter stems and stunted plants. Plants in the treated plots were higher (20.2 cm in 1989) than those in the untreated plots. Soybean aphids significantly affected soybean yields. Yields in the untreated plots reduced 27.8% compared to that in the treated plots in 1989.

Key words: *Aphis glycines*, soybean yield.

The soybean aphid, *Aphis glycines* is one of the major pests in the seedling stage, which may cause serious damage to soybeans. Aphid infestation has currently become an important problem in soybean production due to the lack of aphid resistant cultivars. Soybeans are usually infested more seriously in middle and east Jilin. Statistic documents of 1987-1989 from Changchun, Shiping, Tonghua and Dongliao showed that about 50%, 70% and 80-90% of planting areas were infested in 1987, 1988 and 1989, respectively. In middle Jilin, serious aphid damage happened in 1987 and 1988, while there was an outbreak in 1989. In east Jilin, there were serious infestations in those 3 years. To understand aphid damage and evaluate the efficacy of chemical treatment, we observed aphid population dynamic and its effects on soybean development and yield in 1989-1990.

Materials and methods

In 1989-1990, experimental filed (1 ha) was located in Jilin Academy of Agricultural Sciences, Gongzhuling. Cultivars Jilin 21 and 25 were planted in 1989 and 1990, respectively. Standard culture practices were used in the planting. After seedlings developed, 5 sites of 50 m^2 were chosen diagonally as untreated plots. Chemicals were sprayed once in the rest of the field during aphid growth (1,500 g/ha of 10% enhanced Dimethoate mixed with water was applied on June 26th). In the sprayed areas, 5 sites were diagonally set as treated plots. Twenty plants in each plot were selected for observation. Aphid numbers on the top leaves of main stem, 3 top

trifoliate leaves and young stems and petiole were counted every 5 days from June 5th to July 30th. Plant height, nod numbers of main stem and developmental stage were also recorded (cf. Fehr and Caviness 1977). Two m^2 of soybeans in the treated and untreated plots were surveyed when soybeans were harvested. Pod numbers (only swollen pods were calculated), damage rate and seed weight were determined.

Results

1. Aphid population dynamics

Numbers of overwintering eggs per 100 twigs were 3,384 and 4,194 in 1989 and 1990, which were greater than the outbreak index (Chen *et al.* 1984). In the untreated plots in 1989, aphids developed earlier and built up quickly. Aphid numbers per 100 plants were over 10,000 and developmental duration was up to 40 d. Aphids in 1990 developed slightly later with a shorter developmental duration. Fluctuations of aphid density per 100 plants in 1989 and 1990 are shown in Fig. 1.

Fig. 1 Population dynamics of soybean aphids in the field

Percentage of plants with aphids is shown in Table 1.

Table 1 Percentage of plants with aphids in the soybean field (per 100 plants)

Date	6.5	6.10	6.15	6.20	6.25	6.30	7.5	7.10	7.15	7.20	7.25	7.30
1989	14	10	50	92	100	100	100	100	100	100	100	97
1990	-	20	35	98	99	100	100	100	100	100	99	98

Aphids first appeared on June 5th and 10th in 1989 and 1990, respectively. In 1989, aphid density per 100 plants reached 10,000 on June 15th and declined to 10,000 on July 30th with a 45-d duration between the two dates. In 1990, the two critical dates were June 25th and July 25th, respectively with a 30-d duration. In 1989 and 1990, 50% of plants had aphids on July 15th and 20th. On June 25th and 30th, aphids showed up on all plants. On July 30th and 25th respectively, aphid numbers decreased obviously.

2. Comparison of aphid density between the untreated and treated plots and effects of aphid density on plant development

Chemical treatment in the treated plots resulted in a lower aphid density. Table 2 shows aphid population fluctuation and plant development.

Table 2 Effect of soybean aphids on soybean growth

Date	No. of aphids per 100 plants		Plant height (cm)		No. of nodes per plant		Growing stage	
	Treated	Untreated	Treated	Untreated	Treated	Untreated	Treated	Untreated
1989								
7.05	18,914	43,131	35.8	28.5	9.1	9.6	Early flower	Early flower
7.20	1,460	42,481	66.7	49.1	13.6	11.4	Full flower	Full flower-early pod
7.25	-	12,743	74.3	54.1	14.8	13.6	Full flower-early pod	Early pod
7.30	-	1,015	77.7	64.8	15.8	14.8	Early pod	Full pod
1990								
7.05	873	82,640	46.3	43.1	10	9.7	Early flower	Early flower
7.20	4,580	21,233	81.1	69.8	14.9	14.2	Full flower	Full flower-early pod
7.25	1,288	4,384	88.6	77.4	18	17	Full flower-early pod	Early pod
7.30	1,346	2,331	90.5	79.1	18.5	18.2	Early pod	Early pod

1) Aphid density in the treated plots obviously decreased after chemical application. Aphid numbers per 100 plants in the treated and untreated plots respectively were 18,914 and 43,131 on July 5th, 1989. Aphid numbers in the treated plots were 44% of that in the untreated plots. On July 20th, aphid numbers in the treated plots (1,460) were only 3% of that in the untreated plots (42,481). In 1990, aphid numbers in the treated plots were 1% and 22 % of that in the untreated plots on July 5th and 20th.

2) Plants significantly had curled leaves and shortened stems in the untreated plots. Plant height in the treated plots was greater than that in the untreated plots (Fig. 2).

Plant height on July 5th was 7.3 cm and 3.2 cm in 1989 and 1990. There was a significant decrease of aphid numbers on July 25th, but the height difference between the treated and untreated plots was the greatest. The difference in 1989 and 1990 was 20.2 cm and 11.2 cm and plant height in the untreated plots was 72.8% and 87.4% of that in the treated plots. On July 30th, soybean development in the untreated plots was compensated gradually and the height difference was smaller. Soybeans were infested more seriously in 1989 than 1990 and the difference of plant height was greater in 1989. But there was not big difference of nod numbers in the 2-year comparison.

Fig. 2 Comparison of soybean plant height in 1989

3) Untreated plants developed slightly earlier than treated ones. In the 2-year experiments, full flower-early pod and full flower was found on July 20th in the untreated and treated plots respectively; while the untreated and treated plots were respectively in the early pod and full flower-early pod stages on July 25th.

Aphid damage leads to contracted and curled leaves, shortened stems, stunted plants and earlier plant development.

3. Effect of soybean aphids on soybean yield

Field sampling results in the seed maturity stage are shown in Table 3.

Table 3 Pod numbers, weight per 100 seeds, soybean yield and aphid damage rate

Year	No. of pods		Weight per 100 seeds		Yield (g/m^2)		Aphid damage rate (%)	
	Treated plot	Untreated plot	Treated plot	Untreated plot	Treated plot	Untreated plot	Treated plot	Untreated plot
1989	30.9	25.8	16	15	261.3	188.7	14.1	18.2
1990	49.3	44	22.7	22	340.5	285.5	1.5	1.3

Pod numbers, seed weight and yield of the treated plots are significantly higher than that of the untreated plots. The treated plots had a lower aphid damage rate than the untreated ones in 1989. In August 1990, Dichlorvos was applied to control the soybean pod borer, *Leguminivora glycinivorella* Matsumura resulting in very low aphid damage rate. There was a 27.8% and 16% yield reduction in the untreated plots compared to the treated ones in 1989 and 1990, respectively.

Variance analysis reveals that there is a significant yield difference between the treated and untreated plots (see Table 4).

Aphid infestation significantly affects soybean yield. During the year with a higher aphid density in the early seedling stage and a longer infestation period, over 27.8% of yield losses may be prevented by chemical control. Assumed that yield on average increases 726 kg/ha and

the market price of soybeans is 1.60 yuan/kg, this yield increase will translate to a value of 1,160 yuan/ha. If the total treatment cost is about 110 yuan including 60 yuan of chemicals, 30 yuan of labor and 20 yuan of appliance usage, the ratio of cost to benefit will be 1:10 meaning a net increase of 1,000 yuan/ha.

Table 4 Variance analysis of the effect of soybean aphids

Year	Source of variance	df	Sum Square	Mean Square	F
1989	Between treatments	1	52,707.6	52,707.6	13.889
	Within treatment	8	30,358.4	3,794.8	
	Total variance	9	83,066		11.260 (P=0.01)
1990	Between treatments	1	47,878	47,878	11.87
	Within treatment	6	24,200	4,033	
	Total variance	7	72,078		5.99 (P=0.05)

When aphid density per 100 plants in the seedling stage reaches 10,000 and over 90% of plants have aphids, significant yield losses may be prevented by timely treatment. In middle Jilin, June 25th is the suitable treatment time in the heavy-infestation year.

References

1. Fehr, W. R., and Caviness, C. E. 1977. The development stage of soybean. Iowa State University, Science and Technology Special Report 80, 3-11.
2. Chen, R. L., Wang, S. Y., Bao, X. Z., Xu, E. P., and Xie, W. M. 1984. Prediction of soybean aphids using overwintering eggs. *Jilin Agricultural Sciences*, 1: 56-61.
3. Mo, G. D. 1984. Agricultural experiment statistics. *Shanghai Science and Technology Press, Shanghai.*