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Study on Space Dynamics of a Natural Population of Aphis glycines Matsumura

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Abstract The spatial distribution of soybean aphids on plants is evidently regulated over time, that is, soybean aphids move from the top parts of plants to lower parts in early period and from lower parts of plants to top parts in late period. The farm species group of soybean aphids shows aggregate distribution in its present process according to an analysis of the aggregate index. But the degree of aggregation of soybean aphids varies in different periods and shows nearly random distribution in its most damaging period.

Key Words: soybean aphid; natural population; space dynamics; aggregate index

Aphis glycines Matsumura is a significant pest in the soybean producing areas of northeast China, and can cause yield reductions above 50% in years of high infestation. Some reports on soybean aphids in China are made as follows: In the 1950's, Wang Chenlun et al. researched plant hosts, occurrence regulation and chemical control of soybean aphids. Zhang Xiurong et al described exterior morphological characteristics of every instar in 1988. Then in 1991, Dai Zonglian reported the effects of population size and damage period on soybean yield. He Fugang et al determined the optimal period and economic threshold for soybean aphid control. To date, however, there has been no report on the spatial dynamics of natural populations of soybean aphids. The author systemically analyzed natural population dynamics of *Aphis glycines* throughout two years (1990~1991) research, which supplied a theoretical basis for field sampling, prediction, and forecasting control of soybean aphids.

1 Material and methods

1.1 Investigation methods

Sampling was carried out at the Agricultural Experiment Station, Jilin Agricultural University. Thirty sample plants were randomly selected each time, by methods of systemic inspection and layered sampling, once every two days. One leaf each was randomly selected from the first emerging portion, top part, middle part and lower part of each plant. The numbers of each instar were counted and recorded for each sampling site.

1.2 Analysis methods

$\dot{m}/\bar{x}$ stands for Aggregation Index ($\dot{m}$ as mean crowding and $\bar{x}$ as mean number of aphids). It was used to analyze the population dynamics of spatial distribution of soybean aphids on plants in the field. When $\dot{m}/\bar{x}>1$, the aphid population shows aggregation (clumped) distribution; when $\dot{m}/\bar{x}=1$, it shows random distribution; when $\dot{m}/\bar{x}<1$, uniform distribution is indicated.

2 Results

2.1 The dynamics of spatial distribution of soybean aphids on plants

Table 1 for the spatial distribution of *A. glycines* shows that the distribution of soybean aphids on plants regularly changed with the development of the plants. In mid-June, soybean aphids migrated to soybean fields in Changchun area. First, they mainly gathered on emerging leaves accounting for more than 70% of total aphid numbers on plant. Then with the growth of the soybean plants, aphids gradually moved to lower parts. In late June, aphid numbers on upper leaves accounted for 43.7% of total aphid numbers on plants. From early July to early August, soybean aphids mostly congregated at the middle part of plants, accounting for 50% of total aphid numbers on plants. In mid-August, the number of aphids on lower leaves reached a maximum of 42.6%. After late August, with the aging of the lower leaves of soybean plants, soybean aphids gradually moved upwards again. In late August, most of the soybean aphids gathered on leaves at the center of the plants, at 50.7%. In early September, however, they

concentrated on middle and upper leaves of the plant at 44.4% and 42.0%, respectively. In mid-September, the aphids again moved to upper plant leaves with a total of 68.5%.

Table 1. The dynamics of space distribution of soybean aphid on plant (1991,Changchun)

Part of plant	Mid-June		Late-June		Early-July		Mid-July		Late-July	
	Aphis No.	Pct.*	Aphis No.	Pct.	Aphis No.	Pct.	Aphis No.	Pct.	Aphis No.	Pct.
First leaf	5.333	72.67	32.93	23.25	47.67	22.11	13.86	4.650	2.377	2.395
Upper leaf	1.741	23.73	38.69	43.70	55.20	25.38	88.91	28.46	15.67	15.78
Mid. leaf	0.264	3.590	34.41	26.71	85.58	38.75	151.7	49.79	67.73	68.23
Lower leaf	0	0	7.549	6.320	29.75	13.77	50.07	17.10	13.47	13.57
Total No.	7.338		112.6		218.2		304.5		99.26	

Part of plant	Early-August		Mid-August		Late-August		Early-Sept		Mid-Sept	
	Aphis No.	Pct.*	Aphis No.	Pct.	Aphis No.	Pct.	Aphis No.	Pct.	Aphis No.	Pct.
First leaf	3.450	2.08	1.405	1.260	0.080	0.80	0.025	0.25	0	0
Upper leaf	25.35	15.34	21.34	22.33	3.550	35.67	4.386	44.11	4.425	61.62
Mid. leaf	87.47	52.83	42.60	33.78	5.089	51.13	4.018	40.41	2.548	35.48
Lower leaf	49.32	29.78	51.95	42.64	1.233	12.39	1.514	15.23	0.208	2.896
Total No.	165.6		120.3		9.952		9.943		7.816	

*: Pct=Percent of total soybean aphid numbers on plants

2.2 The dynamics of spatial distribution of soybean aphid population in the field

The spatial distribution of soybean aphids in the filed also varied by period. Table 2 shows the population dynamics of spatial distribution according to analysis of aggregation index ($\dot{m}/\bar{x}$). The dynamic curves of $\dot{m}/\bar{x}$ value are displayed in Fig.2 (1991,Changchun). From Fig. 2, it is noted that dynamic curves of spatial distribution of soybean aphids in the field were always above $\dot{m}/\bar{x}$ =1, thus aggregate distribution was indicated. However, the aggregation varied in different periods: the aphid population showed obvious aggregation distribution before early July when soybean aphids migrated into the field. But from early July to early August, the aphid population exhibited random distribution which is the most damaging period when soybean aphids reproduced and spread further in the field. After early August, environmental factors restrained aphid reproduction, so the number of aphids decreased, then the aphids enhanced the degree of aggregation.

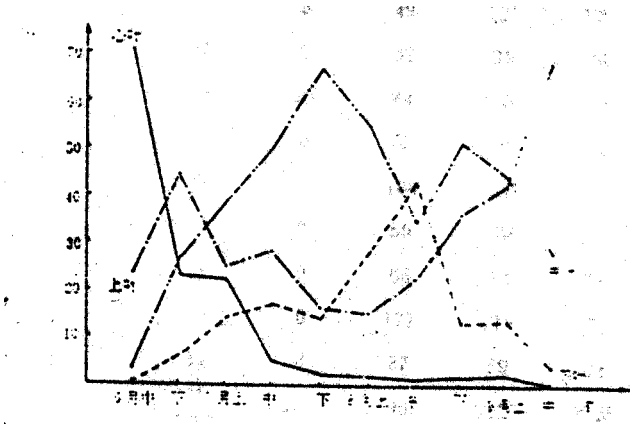

Fig.1 Space distribution of soybean aphid on plants

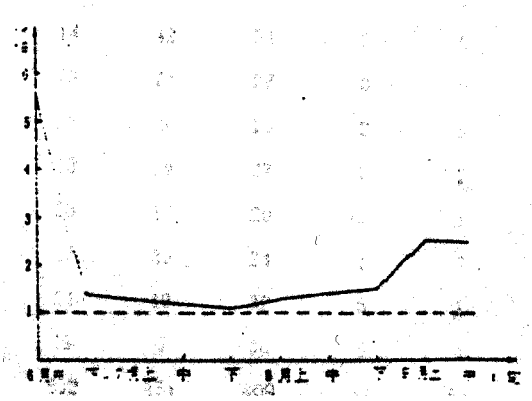

Fig.2. Spatial distribution of soybean aphids on plants in the field

Table 2. The tendency of the spatial distribution of population of soybean aphid in the field(1991, Changchun)

Sampling order	No. of soybean aphid									
	mid-June	late June	early July	mid-July	late July	early Aug.	mid-Aug.	late Aug.	early Sep.	mid-Sep.
1	0	159	65	71	10	11	10	2	0	0
2	0	22	88	135	15	14	9	1	1	0
3	0	29	144	98	44	67	11	6	3	1
4	0	37	71	135	25	45	19	7	0	0
5	0	60	154	94	8	28	10	1	5	0
6	0	97	273	73	17	46	8	3	6	0
7	0	94	66	175	10	1	63	3	3	1
8	0	28	97	98	18	43	27	0	0	2
9	6	13	156	105	15	20	21	0	4	0
10	0	33	175	41	24	13	80	0	0	0
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3 Brief summary and discussion

1) Through two years of systematic investigation, the authors found that spatial distribution of soybean aphids on plants varied significantly and consistently in accordance with soybean plant growth and climatic conditions. That is, when they migrated to soybean field, *A. glycines* mainly concentrated on the tender leaves and damaged soybean plants by feeding. With growth of the soybean plants and increasing temperatures, the *A. glycines* population tended to move to the lower parts of plants. Due to high temperatures and heavy rainfall, the soybean aphid collected at the middle-lower parts of host plants which offered more shade. After late August, as ambient temperatures dropped and rainfall reduced, soybean plants aged gradually from the lower parts of the plant toward the top. Soybean aphids also transferred from the lower to the upper parts of the plants.
2) There was aggregation distribution ($\dot{m}/\bar{x}>1$) throughout the occurrence of soybean aphids in the field. However, aggregation degree varied in different periods, closing to random distribution at the peak of damage. The population dynamics of spatial distribution of soybean aphids reflected the course of damage of *A. glycines* in the field. When the ($\dot{m}/\bar{x}$) ratio is close to 1, the more serious the damage will be.
3) According to these results, when the occurrence, control, and prediction of soybean aphid are analyzd we should consider the spatial distribution of soybean aphids on plants during sampling surveys in the field, and find out the most scientific methods of sampling. The authors note that it is feasible to take the 'aggregate index' ($\dot{m}/\bar{x}$) as anindex to predict and forecast the occurrence of

soybean aphid and to study appropriate control periods.

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