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The relationship between the level of lignin, a secondary metabolite in soybean plant, and aphid resistance in soybeans

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Abstract

In the present report, the relationship was discussed between the level of lignin—one of the secondary metabolites in soybean plant and the chemical defense reaction of soybean to the soybean aphid (*Aphis glycines* Muts). Experimental results indicated that the cultivars with higher level of lignin are more resistant to the damage of aphids than those with lower level of lignin. Lignin is one of the compounds that are responsible to the chemical defense reaction of soybean. This finding laid a foundation for the elucidation of the mechanism of aphid resistance in plants and its biochemical basis.

Key words: soybean aphid, lignin, secondary metabolites

Plant defense against insect pests is reflected by morphology, histo-anatomy properties or biochemical properties. When plants are suffering from the attacks by insect pests, certain chemical elements in the plant may become important factors of chemical defense response to insects. Plants with differing levels of secondary metabolites show differences in their defense responses to insect pests. Lignin is one of the secondary metabolites in soybean plant, and the relationships between the level and its fluctuation of lignin and the chemical defense reaction of soybean plants to the soybean aphid are reported below.

1. Sample collection and test methods

1.1 Collection and preparation of soybean samples: 5 soybean cultivars that had been infested by aphids were selected on July 28, 1989 at the soybean fields in the experiment station of Jilin Agricultural University. Total fifteen leaf samples (each includes 3 leaves from the top, middle and lower part of a soybean plant) were collected randomly out of 15 soybean plants from 5 sites (3 plants/site) along the diagonal of the field. Fifteen control samples (protected from the infestation of aphids by nylon net) were collected by the same method. The leaf samples were air-dried, ground into powder and mixed thoroughly. Total

0.1 grams each of the ground samples were weighed by analytical balance and used as test samples, 3 times repetition per sample.

1.2 Measurement of the lignin level

According to the reaction formula of the oxidation of lignin by potassium dichromate ($K_2Cr_2O_7$):



The left-over un-reacted potassium dichromate was titrated by iodine method. The lignin level was calculated by the following formula: lignin level (X) = $0.433 \times k(a-b)/n$

where a stands for the volume (ml) of sodium thiosulfate ($Na_2S_2O_3$) used for the titration of the control liquid of potassium dichromate; b stands for the volume (ml) of sodium thiosulfate used for the titration of the un-reacted potassium dichromate; k stands for the Normal concentration (N) of sodium thiosulfate; and n stands for the weight of the sample.

2. Results and Analysis

The results of the test of lignin level in samples infested by aphids and the control samples are summarized in the table below.

Table 1. The lignin level and infestation indexes (%) in the soybean leaves of different cultivars (1991).

		Tiefeng 24		Jilin 21		Changnong 4		Jilin 20		Jinong 82	
		Infes	CK	Infes	CK	Infes	CK	Infes	CK	Infes	CK
Leaf Position	Upper	2.54	1.73	0.22	0.1	2.17	0.87	1.95	1.94	2.67	1.30
	Middle	2.13	1.95	2.36	2.30	2.68	2.38	3.46	1.08	1.73	0.87
	Lower	2.69	0.65	2.11	1.88	5.41	0.2	1.08	0.76	6.35	2.17
	Sum		4.33		4.28		3.87		3.78		3.54
Infest. Index	June 20	28		23		46		50		54	
	July 17	79		85		93		99		150	

The lignin level in leaves from all parts of the plant of the cultivar Tiefeng 24 is the highest, the infestation index is the lowest, and the damage is the least. The lignin level in leaves from all parts of the plant of the line Jinong 82 is the lowest, and the infestation index is the highest. The infestation indexes of two investigations are 54% and 150%. Those cultivars with higher level of lignin are comparatively resistant to aphids, have lower infestation index. The situation is the opposite for those cultivars with lower level of lignin.

The data in the table indicated that the lignin level in the infested leaves was

higher than that from the control plants. This finding suggested that the lignin level in soybean plants was increased after infestation due to defense response induced by insect attack on the plants to fight back and reduce the damage, in addition to the normal lignin level in soybean plants involved in chemical defense mechanism.

The results of our experiments suggested that lignin is one of the substances involved in the chemical defense mechanism in soybean plants against soybean aphids, and that the level of lignin is closely related to the intensity of defense response. Those cultivars with higher level of lignin in their leaves possess greater resistance against the aphids. Hence this secondary metabolite is a component of the biochemical mechanism in soybean against the aphids. With the advance in chemical ecology and biotechnology, many biochemical factors have been found involved in insect resistance, such as the level of various amino acids, concentration of organic acids, soluble saccharides, the level of nitrogen and that of tannin. Those findings have been highly appreciated by the people engaged in plant breeding and plant protection, and will provide ideal materials for research and development.

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