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Activation of Soybean Plant Defense Signaling Pathways in Response to Soybean Aphid (*Aphis Glycines* Matsumura) and *Soybean Mosaic Virus*

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I. BACKGROUND

- **Soybean Plant**
  - Soybean (*Glycine max*) also called the “miracle crop”, is the primary source of vegetable protein and oil for millions of people all over the world [1] (Fig. 1).
  - Currently, U.S. is the leading producer of soybean in the world with 831.18 million metric tons [1].

Fig.1. Soybean plant with pods

- **Soybean Aphid**
  - The biggest threat to soybean production is an insect pest, the Soybean Aphid (SBA) (Fig. 2).
  - Aphid feeding causes leaf puckering, plant stunting, reduced pod and/or seed counts, contributing up to 45% yield loss [2].

Fig.2. Soybean aphid

- **Soybean Mosaic Virus**
  - In addition to direct damage through feeding, SBA cause indirect damage by transmitting plant viruses such as the *Soybean mosaic virus* (SMV) (Fig. 3) [3].
  - The major impact of SMV is the effect on seed quality.

Fig.3. SMV-infected plant

II. LONG-TERM AND SHORT-TERM OBJECTIVES

- **Long-term Objective**
  - To identify plant genes that contribute host plant resistance to aphids and aphid-transmitted viruses and may be used to develop resistant soybean varieties.
- **Short-term Objective**
  - Determine the timing and nature of plant defense responses against SBA infestation and SMV infection.

III. METHODS

- **Plant, insect and virus source**
  - Soybean variety AG3432 was used for all experiments. Plants were grown at 24 ± 1ºC and 16:8 hours (light: dark cycle).
  - Soybean aphids were obtained from Purdue University, West Lafayette.
  - SMV-infected plants were obtained from University of Illinois.
- **Experimental Design**
  - The experiment design consisted of three plant treatments - 1) infestation with twenty SMV-infected soybean aphids, 2) infestation with twenty uninfected aphids, and 3) no treatment or control plants. There were 2 replicates per treatment.
  - Plant tissues were collected at five sampling time points – 0h, 3h, 6h, 12h, and 24h post-release of aphids.
- **Gene Expression Analysis**
  - Plant RNA was extracted following Trizol® extraction method. The quality and quantity of the RNA was verified using a Nanodrop® Spectrophotometer.
  - The DNA-free RNA was used for complementary DNA (cDNA) synthesis and gene expression analysis using reverse-transcriptase-Polymerase Chain Reaction (RT-PCR.

IV. RESULTS

- **Aphid Populations**
  - There was slightly greater mortality (7.5%) in SMV-infected aphids after twenty SBA were initially placed on plants (Table 1).

Table 1. Number of soybean aphids on plants at time of leaf tissue collection.

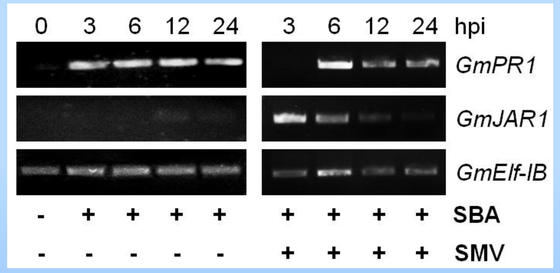
Hour	Number of uninfected SBA	Number of SMV-infected SBA
0	-	-
3	20	18
6	20	18
12	20	19
24	19	18

IV. RESULTS (CONTD.)

- **Plant Defense Gene Expression**
  - The two main plant defense pathways that were analyzed in the study were: Salicylic acid (SA) -pathway and Jasmonic acid (JA) -pathway.
  - The SA pathway is predominantly induced against pathogens and the JA pathway is activated in response to insect feeding [4].
  - In our study, *GmPR1* – marker gene for SA pathway was activated in response to feeding by uninfected SBA and SMV-infected SBA (Fig. 4).
  - *GmJAR1,* a marker for JA pathway, was activated to a greater extent in response to feeding by SMV-infected aphids (Fig. 4).

To summarize, simultaneous attack by SBA and SMV results in the activation of both SA and JA defense pathways in soybean plants.

Fig. 4. Plant Defense Signaling Gene Expression



V. REFERENCES

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VI. ACKNOWLEDGEMENTS

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