

Soybean Aphid Development on, and BCMV Transmission to, Otebo Dry Bean

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DiFonzo, C., and Agle, K. 2008. Soybean aphid development on, and BCMV transmission to, Otebo dry bean. Online. Crop Management doi:10.1094/CM-2008-0916-01-RS.

Abstract

The non-native soybean aphid (SBA), *Aphis glycines*, is now common on soybean across the Midwest. Dry beans are not listed as a host for SBA, but SBA outbreaks in Michigan correspond with increased incidence of *Bean common mosaic potyvirus* (BCMV) in susceptible dry bean varieties. This study examined SBA development on and BCMV transmission to Otebo beans. SBA females deposited nymphs on dry bean foliage after two days in the laboratory and field, but survival and reproduction were less on dry bean than on soybean. After six days in the laboratory and field, all adults and nymphs were dead on dry beans. However, studies using winged SBA confirmed their ability to transmit BCMV from and to Otebo dry bean.

Introduction



Fig. 1. Heavy soybean aphid infestation on soybean in an outbreak year, 2005, Saginaw Co., MI.

The non-native soybean aphid (SBA), *Aphis glycines* Matsumura (Hemiptera: Aphididae), was discovered in the USA in 2000 and is now common on soybean [*Glycine max* (L.) Merrill] across the Midwest. In outbreak years (Fig. 1), millions of alate (winged) SBA are generated per acre of soybean, with the potential to transmit plant viruses. Since its establishment, SBA has been shown to transmit potyviruses to soybean and snap bean (3,5). Dry bean (*Phaseolus vulgaris* L.) is colonized by several aphid species,

but it is not listed as a host for SBA (1,2). However, SBA outbreaks in Michigan correspond with increased incidence of *Bean common mosaic potyvirus* (BCMV) in highly susceptible dry beans (Figs. 2a and 2b), particularly those in the Otebo market class (4). The goal of this work was to determine if SBA developed on, or transmitted BCMV to, dry bean. We focused on Otebo beans, grown in Michigan for export to Japan to produce confectionary bean paste.



Fig. 2a. Nearly 100% of the plants in this commercial Otebo dry bean field exhibited visual symptoms of *Bean common mosaic potyvirus* in 2005, Saginaw Co., MI.



Fig. 2b. Close-up of virus-infected Otebo dry bean field, 2005, Saginaw Co., MI. Leaf samples were DAS-ELISA tested to confirm BCMV infection.

In the laboratory, SBA survival and reproduction was compared by placing single adult apterous (non-winged) females on individual soybean (var. Williams) or dry bean (var. Hime, market class Otebo) leaflets in Petri dishes. Leaflets were taken from field-grown plants and petioles were inserted into microfuge tubes to provide water for several days. There were 97 replications (individual females) for each host, for a total of 194 Petri dishes. Dishes were held in an incubator at 25°C with 16:8 lighting. Adult survival and nymph production were recorded after two days. Surviving nymphs were removed from the original leaflets and consolidated onto fresh soybean or dry bean foliage to observe survival after six days. In the field, single apterous adults were individually clip-caged onto leaflets of 10 soybean, or 30 dry bean, plants. Aphid-proof screening on the clip cage kept aphids in, but excluded predators (Fig. 3). Adult survival and reproduction were recorded after two and six days. Chi-square and multinomial tests were used to compare survival and reproduction on dry bean versus soybean.



Fig. 3. Predator-proof clip cage used to confine individual aphids on leaflets.

After two days in the laboratory, adult survival and the number of adults reproducing was significantly less on dry bean than soybean (Table 1). Although SBA deposited nymphs on dry bean foliage, the total number produced on dry bean was significantly less than on soybean. After six days, 65% of the nymphs deposited on soybean were still alive, but all were dead on dry bean. After two days in the field, adult survival and reproduction was again significantly less on dry bean than soybean (Table 1). After six days, 80% of adults were still alive and continuing to reproduce on soybean, but all adults and nymphs were dead on dry bean.

Table 1. Soybean aphid survival and reproduction on dry bean and soybean.

Host plant	After 2 days			After 6 days		
	Adults surviving	Adults reproducing	Nymphs, total and per adult*	Adults surviving	Nymphs surviving	Nymphs, total and per adult
Laboratory						
Dry bean	38/97 39%	34/97 35%	80/97 0.8	—	0/80 0%	—
Soybean	76/97 78%	72/97 74%	315/97 3.2	—	204/315 65%	—
X ² value; P value	30.7 < 0.000	30.0 < 0.000	139.8 < 0.000	—	107 < 0.000	—
Field						
Dry bean	15/30 50%	12/30 40%	16/30 0.5	0/30 0%	—	0/30 0
Soybean	9/10 90%	8/10 80%	11/10 1.1	8/10 80%	—	33/10 3.3
X ² value; P value	5.0 0.025	4.8 0.028	3.6 0.059	30.0 < 0.000	—	99.0 < 0.000

* Nymphs per adult was calculated based on the total number of females at the beginning of the study, since aphids can reproduce (deposit live nymphs) prior to death.

To determine if SBA transmitted BCMV to dry bean, a symptomatic dry bean plant was collected from a university breeding trial and confirmed by DAS-ELISA through Michigan State University (MSU) Diagnostic Services (Agdia testing services, Elkhart, IN, www.agdia.com; criteria for positive sample = 2× negative control reading). The BCMV culture was maintained in, and manually transmitted to, cv Hime plants grown from virus-free seed provided by the MSU Dry Bean Breeding and Genetic Program. Virus-free test plants were grown from the same seed lot. Virus-infected and test plants were kept in separate rooms in a greenhouse complex. Alate SBA from a greenhouse colony, reared on virus-free soybean, were used for transmission, as winged forms are key for virus movement in the field. Transmission was done using 1 (n = 45) or 5 (n = 17) alates per plant. Aphids were starved for 1 h, then given a 5-min acquisition period on virus-infected leaflets. Aphids were immediately moved to small, healthy test plants and caged with an inverted 50 ml tube (Corning #430290). Aphids were left on test plants for 24 h, then tubes were removed, the SBA crushed, and test plants sprayed with insecticide. Test plants were kept in an insect-proof greenhouse for 21 days. Visual inspection for infection was confirmed by submitting leaflets from all test plants through Diagnostic Services for ELISA testing, along with leaves from known infected BCMV source plants and healthy controls not exposed to viruliferous aphids. BCMV transmission was 22% (10/45) and 23% (4/17) using 1 and 5 SBA per plant, respectively. This is the first confirmation of transmission of BCMV from dry bean to dry bean by SBA in North America.

Although SBA deposited nymphs on dry bean foliage, adults did not survive long and nymphs did not complete development. However, SBA transmitted BCMV relatively efficiently to Otebo beans. Thus the major impact of soybean aphid on dry bean production is expected to be virus transmission to susceptible varieties, not direct colonization and feeding damage.

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