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Impact of Bean Pod Mottle Virus on Soybean Yield and Quality in Iowa

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Abstract

Bean pod mottle virus (BPMV) was the second most prevalent disease of soybean in Iowa (Iowa Soybean Disease Survey 2005 through 2007). The principal means of BPMV spread is by insect vectors, with the bean leaf beetle (*Cerotoma trifurcata* Forster) being the most important and abundant vector. This virus also can be seedborne, resulting in seed-to-seedling transmission, with BPMV-infected seedlings serving as a source of virus infection within the soybean crop. Although the first report of BPMV in the North Central United States originally occurred in Iowa, the impact of BPMV on soybean yield and quality had not been well documented. This project focused on quantifying the effect of time of BPMV detection (related to time of infection) on soybean yield and grain quality.

Keywords

Plant Pathology

Disciplines

Agricultural Science | Agriculture | Plant Pathology

Impact of Bean Pod Mottle Virus on Soybean Yield and Quality in Iowa

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Introduction

Bean pod mottle virus (BPMV) was the second most prevalent disease of soybean in Iowa (Iowa Soybean Disease Survey 2005 through 2007). The principal means of BPMV spread is by insect vectors, with the bean leaf beetle (*Cerotoma trifurcata* Forster) being the most important and abundant vector. This virus also can be seedborne, resulting in seed-to-seedling transmission, with BPMV-infected seedlings serving as a source of virus infection within the soybean crop. Although the first report of BPMV in the North Central United States originally occurred in Iowa, the impact of BPMV on soybean yield and quality had not been well documented. This project focused on quantifying the effect of time of BPMV detection (related to time of infection) on soybean yield and grain quality.

Materials and Methods

Soybeans (cv. NE3001) were planted on May 5, May 18, and June 20, in 2006, 2007, and 2008, respectively, at the Iowa State University Curtiss Research Farm in Ames, IA. Plots measuring 8 rows by 35 ft long were delineated after soybean emergence by establishing twenty-five, 30-cm-long (1-ft) quadrats within each of the six center rows of soybeans. There were four treatments with three replications per treatment (12 plots) used in an attempt to determine the temporal and spatial dynamics of BPMV spread in soybeans. Treatments were: 1) establishing a point source of BPMV within soybean plots; 2) foliar insecticide (Warrior) applied at the V1 (first true leaf) and R2 (flower set)

soybean growth stages; 3) establishing a BPMV-inoculated point source, plus two foliar applications of insecticide at V1 and R2; and 4) a non-treated, non-inoculated control. Sampling to detect BPMV began 25 days after planting and continued at 8- to-11-day intervals until crop senescence. Leaf sap was extracted from each soybean leaf sample and tested for the presence of BPMV by ELISA. Quadrat position (plot, row, and quadrat number) and the sampling date that each quadrat first tested positive for BPMV were recorded and mapped. As a measure of how fast BPMV could spread from plant-to-plant within soybean plots, doubling times were calculated for each growing season. To determine the effect of time of BPMV first detection on soybean yield, yield components, and grain quality, 35 soybean quadrats representing each date that BPMV was first detected were harvested. The soybean yield, number of pods per plant, number of seeds per pod, and 100-seed weight were then determined for each detection date. The relationship between time of BPMV detection (infection) and grain yield, yield components, and grain quality was quantified using linear regression.

Results and Discussion

- The incidence of BPMV in soybean plots varied during the three-year study, with BPMV incidence reaching the highest levels (75–99 percent) in 2006.
- In 2007, the incidence of BPMV was low-to-moderate (10–50 percent) due to the low winter survival of bean leaf beetles.
- In 2008, BPMV was not detected in soybean plots due to delayed planting and low winter survival of the bean leaf beetles.

- The rate of BPMV plant-to-plant spread in soybeans varied among the three growing seasons, with the highest BPMV infection rate occurring in 2006. Conversely, the rate of BPMV infection during the 2007 growing season was much slower (about half as fast as 2006) due to lower bean leaf beetle populations following the 2006–2007 winter.
- The doubling time (i.e., the time for BPMV incidence to increase from 1 to 2 percent, from 2 to 4 percent, or from 4 to 8 percent, etc.) was fastest in 2006, with BPMV incidence doubling every 5.3 to 6.9 days.
- In 2007, BPMV incidence doubled every 9.9 to 13.9 days.
- In 2008, there was no spread of BPMV due to extremely low bean leaf beetle population densities, and therefore, no doubling times could be calculated. Thus, risk of BPMV incidence varied among years and was closely related to the size of the bean leaf beetle population densities that survived the winter.

The 2005–2006 winter was characterized by warm days that led to high winter survival of bean leaf beetles. The winter of 2006–2007 was much colder, hence, the bean leaf beetle populations were lower in 2007. The 2008 growing season was delayed because of flooding due to heavy spring rains, which delayed soybean planting. As a result, the overwintering and first summer bean leaf beetle populations were very low in many soybean fields in Iowa and beetles did not acquire and spread BPMV in soybeans in 2008.

Time (day of year) of BPMV detection explained 57.9 percent and 89.7 percent of the variation in soybean grain yield in 2006 and 2007, respectively, with greater yield losses occurring the earlier BPMV was first detected in the field (Figure 1). The yield damage function (slope) was -0.23 bushels/acre/day in 2006 and -0.12 bushels/acre/day in 2007.

- Thus, for every 4.3 days BPMV detection was delayed in 2006, soybean yield would increase by one bushel.
- In 2007, soybean yield increased by one bushel for every 8.3 days that BPMV detection was delayed.
- The percentage of mottled seeds in 2006 decreased by 0.34 percent for each day that BPMV detection was delayed.
- In 2007, a 1-day delay in BPMV detection resulted in 0.15 percent decrease in percent mottled seed.
- Protein and oil content were not affected by time of BPMV detection in a quadrat in both years, however, protein and oil content tended to be affected inversely (slope = -0.67, $R^2 = 98.2\%$), indicating quadrats that had early BPMV tended to have high protein content and low oil content.

These studies indicate that soybean growing seasons following mild winters will result in high BPMV incidence. Management practices that target overwintering population will be effective in reducing BPMV risk. Also the earlier the BPMV infection, the greater the yield loss, therefore, management practices that delay time of BPMV infection will reduce yield losses due to BPMV infection.

Acknowledgements

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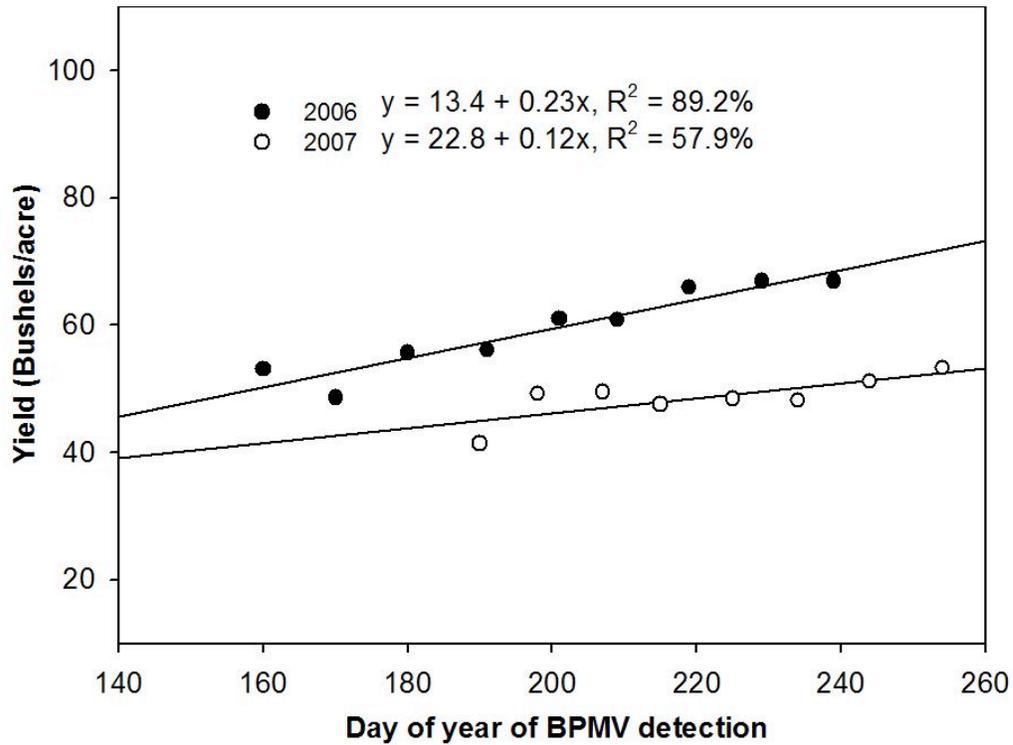


Figure 1. Relationship between day of year that *Bean pod mottle virus* was first detected and the yield of soybeans (cv. NE3001) planted at the ISU Curtiss Farm near Ames, IA in 2006 (solid circle) and 2007 (open circle).