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Epidemiology of Soybean Mosaic Virus Diseases

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콩모자이크바이러스病의 疫學的 硏究

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ABSTRACT: Two soybean cultivars Haman and Kwanggyo were used to monitor SMV spread in the field. The Haman producing mosaic symptoms by infection with SMV strain G7 was planted in 2.2 m² at the center of 320.7 m² field and Kwanggyo producing necrosis by infection with SMV-G7 was planted around the Haman one day after inoculation of Haman with SMV-G7. The most severe incidence of the necrotic disease in soybean cultivar Kwanggyo occurred on 43 days after planting (July 13) whereas aphid population reached peak around 22 days after planting (June 22). Total incidence of the necrotic disease was 20.4% in the whole field and 56% in eight small plots around the spreader of SMV. The spread of SMV outward from the spreader source was greater downwind than it was upwind. Spread also showed a signigicant gradient pattern leeward from the infection focus.

INTRODUCTION

The soybean necrotic disease had been found to be caused by some strain of soybean mosaic virus (SMV) in certain combinations of soybean genotype and SMV strain[1,2]. The SMV strains virulent to soybeans resistant to mosaic disease, or less virulent SMV strains were found to be relevantly transmissible by aphids[3].

The necrotic disease is so devastating that virtually gives no yield at all when infection occurred at early stage of growth as in soybean cultivar Kwanggyo. However, late infection with virulent SMV strains results in partial development of necrotic symptoms, for example, on the branches of infection site rather than in the whole plants. When seeds were harvested from the partially diseased plants, no seed transmission of SMV was detectible either by visual observation or by the serological methods[9].

Many different SMV strains could be identified from soybean leaves showing mosaic symptoms of a soybean genotype. However, it appeared that certain soybean cultivars transmitted certain virulent strains selectively especially when the soybeans were resistant to other strains and susceptible to the specific strain[4]. In Korea, soybeans of different genotypes are usually cultivated in the small size of farm. Therefore, the necrotic disease usually occurred in soybeans resistant to mosaic disease such as in Kwanggyo and Hwanggeum-Kong when the native soybean cultivars are cultivated nearby and the native cultivars transmit SMV through the

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seeds. This study was conducted to determine factors affecting the outbreak of the necrotic disease and spread of the SMV infection by providing spreader source at the center of the field. The authors gratefully acknowlege the help of Mr. W. T. Cho during the study.

MATERIALS AND METHODS

Experimental field: The experiments were conducted in the Institute of Agricultural Sciences (IAS) farm in Suweon in 1982. Experimental field of 320.76 m^2 (16.2 × 19.8) consisted of 99 small plots of 3.4 m^2 (1.8 × 1.8) (Fig.1). Each plot was numbered by 01 through 11 in rows and 1 through 9 in the column as indicated in Fig.1. Soybean cultivar Haman was planted on May 17, 1982 in the plot 506 located at the center of the field. Kwanggyo was planted on June 1, 1982 in 98 small plots around the Haman. In each small plot, there were four rows planted with two or three seeds by 15cm apart in a row, 60cm apart between rows. Seeds of Haman and Kwanggyo used were increased in the IAS Farm in 1981.

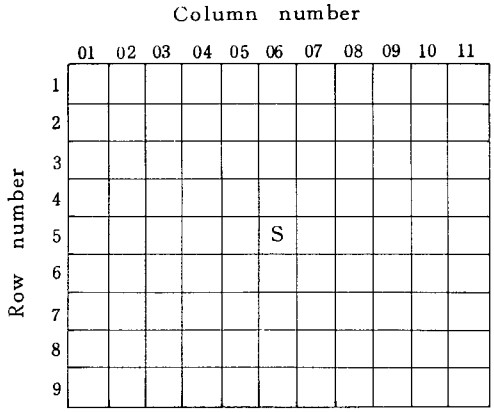

Fig.1. Design of experimental soybean field plot(16.2 × 19.6m) consisting of 99 small plots(1.8 × 1.8m) for the study of SMV spread from spreader source(S). The spreader was soybean cultivar Haman inoculated with SMV-G7 and reader plants were Kwanggyo showing necrosis by infection with SMV-G7.

For aphid collection a yellow trap(50 × 35 cm) filled with water was placed in the row of the plot 506. The height of the yellow trap was adjusted to the height of canopy level of soybean. Aphids from the yellow trap were collected two times a week and identified in the lab. To count number of aphids on leaves of soybean cv. Kwanggyo, 20 plants were randomly selected around the soybean cv. Haman and nine leaves of each plant were observed for aphids. Counting number of aphids from leaves were made on June 29, July 6, July 13, July 20, July 28, Aug. 2, Aug. 10 and Aug. 17, 1982.

Inoculation and reading: The SMV strain G7 was used as a spreader source to monitor necrotic disease of soybean cultivar Kwanggyo. The strain caused necrosis in soybean cultivar Kwanggyo and mosaic symptom in Haman. Haman plants in the plot 506 were mechanically inoculated with G7 on June 2, 1982. Leaves of Haman showing mosaic symptom about 20 days after sap inoculation were taken to grind in 0.01 M sodium phosphate buffer (pH 7.0) in the ratio of one to five (w/v) to prepare inoculum. Inoculation was made by rubbing primary leaves of soybean with a cotton piece dipped into inoculum added with a small amount of Carborundum (600 mesh).

Incidence of the necrotic disease in Kwanggyo was observed on June 17, June 29, July 6, July 13, July 20, July 27, Aug. 3 and Aug. 18. Each of diseased plants was marked with a small piece of plastic label at each reading day. Severity of necrotic disease was compared by calculation percentage of diseased plants over plants observed in each small plot. For analysis of gr-

adient pattern of SMV spread the percentage was transformed according to Gregory's method[5], and significance was tested statistically.

RESULTS

Incidence of Soybean Necrotic Disease: Development of the necrotic symptoms in leaves of Kwanggyo (reader plants) was observed from June 17, 15 days after planting of Kwanggyo, and severe necrosis including bud blight was observed from June 29, 27 days after planting. The first day of symptom development matched with 17 days after inoculation to Haman plants (spreader source) while 91% of Haman plants produced mosaic symptoms 14 days after sap inoculation with SMV strain G7. The total number of Kwanggyo plants were 15,048 and Haman plants were 171 plants in the whole experimental field. Thus the ratio of spreader plants over reader plants was approximately 1.0% since 91% of 171 Haman plants were infected.

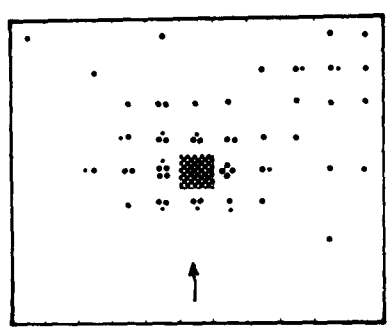

Fig.2. Incidence of the soybean necrotic disease in soybean cultivar Kwanggyo in the experimental field (320.7m²) when plants of soybean cultivar Haman at the center of the field (□) were inoculated with SMV strain G7 at 15 days after planting. Small dots indicate 10% and larger dots indicate 20 % of diseased plants in each small plot (2.2m²). The arrow indicates the most prevalent wind direction.

Incidence of the necrotic disease ranged from 7.8 to 87.1 % in each plot throughout the field when diseased plants in each plot was counted up to Aug. 18. Most diseased plants were found in plots leeward from the spreader although the percentages of diseased plants in plots around the spreader ranged from 32.8 to 87.1 % (Fig.2). The diseased plants recorded on each reading day were 362, 73, 213, 810, 514, 407, 204, 301 and 184 plants in Kwanggyo on June 17, June 29, July 6, July 13, July 20, July 29, Aug. 3, Aug. 10, and Aug. 18, respectively.

Aphid: Total number of aphids collected in the yellow trap was 752 from June 17 to Aug. 18. Among the 752 aphids, *Myzus persicae* was 31%, *Aphis spiraecola* was 7.6 %, *Aphis glycines* was 4.8%, *Lipaphis erysimi* was 1.2%, *Macrosiphum euphorbiae* was 0.8 %, *Aulacorthum solani* was 0.3 %, and *Aphis gossypii* was 0.1%. However, 45% of aphids was caught on June 22.

Accumulated number of aphids from leaves of Kwanggyo were 1,180 consisting of 1,073 of *A. glycines* (90.9 %), 97 of *A. solani* (8.2 %), nine of *M. persicae* (0.7 %) and one of *A. gossypii* (0.1 %). from June 29 to Aug. 17. In 1,073 of *A. glycines*, alate was 1.4 %, apterous was 30%, and nymph was 59.7 %. Of the 1,180 aphids, 72.7 % of them was found by July 6.

Gradients of SMV spread: Of the total 15,048 plants of Kwanggyo observed, 3,068 plants were found to be diseased until Aug. 18 in the whole field. Proportional incidence of the necrotic disease at each reading day showed that the maximum incidence occurred on July 13, whereas the peak of aphid population was on June 22 (Fig. 3). Analysis of disease severity columnwise, for example, in the column 06 including

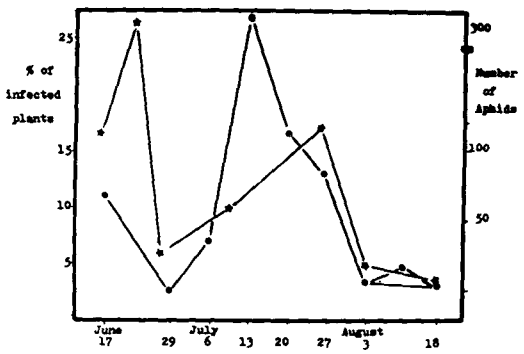

Fig. 3. Per cent of soybean necrotic disease incidence (•——•) and number of aphids collected (▲——▲) in the yellow trap placed in the center plot (plot 506) in the field.

plots 106 through 906, indicated that spread of SMV formed gradient pattern in plots leeward from the spreader. Such a linear relationship was found to be signigicant between disease severity and distance from the spreader in plots leeward from the spreader in the column 06, 05, 04, 07 and cross 1 including plots 407, 308, 209 and 109 but not in plots opposite to wind direction from the spreader even in the same column and cross 2 including plots 102, 203, 304, and 405 (Fig.4)

DISCUSSION

Spread of SMV within a soybean field might depend upon several factors, including level of primary inoculum foci; numbers and species of migratory alate aphids; and prevalent wind directions from the spreader source of SMV[3,6,7,10]. Our data confirmed that the necrotic disease in soybean cultivar Kwanggyo occurred by infection with a virulent SMV strain transmitted by aphids because of lack of seed transmission of SMV in those necrosis-susceptible cultivars[1,3,4,9]. Our results also showed not only that soybean cultivars producing mosaic symptoms

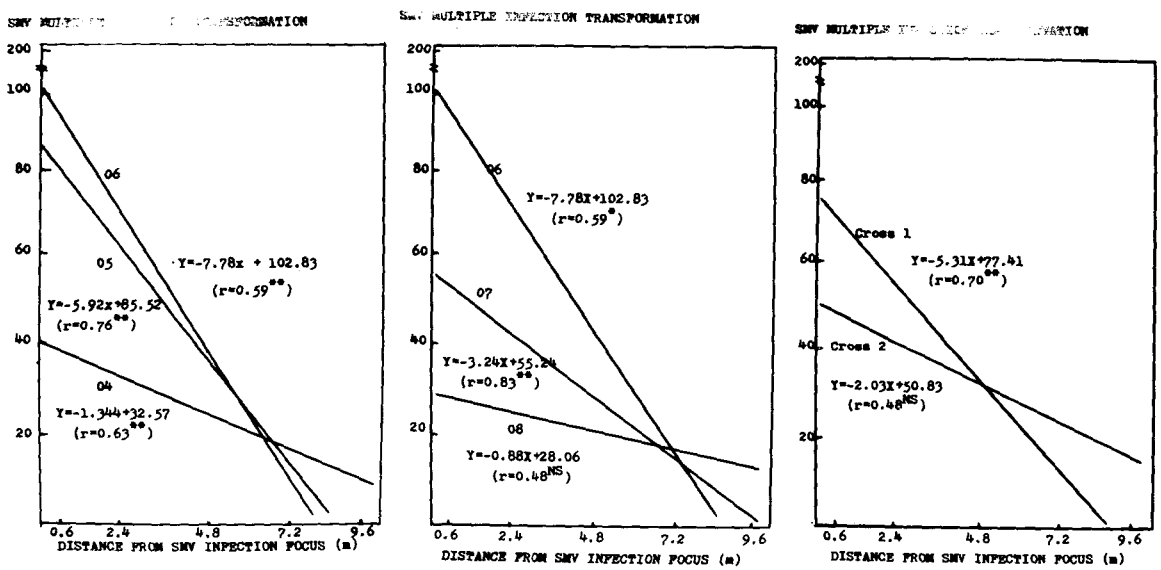

Fig. 4. Relationship between severity of soybean necrotic disease and distance from the infection focus of soybean mosaic virus in plots located leeward from the spreader (infection focus) in the columns (See Fig.1 for plot explanation).

played a major role in the outbreak of necrotic disease but spread of necrotic disease was also influenced by prevalent wind direction and density of aphid population as happened in mosaic disease[10].

Thirty one species of aphids have been reported to transmit SMV[10]. Two species of aphids, *Aphis glycines* Matsumura and *Aulacorthum solani* (Kaltenbach), were known to colonize soybean in Korea[8], however, transient alate aphids, the green peach aphid in our case, appeared to be responsible for the spread of SMV in our study. Halbert et al.[7] reported that five species of aphids accounted for more than 93% of SMV transmission in a field of central Illinois in USA. Thus it is probable that SMV transmission in the field might be influenced by efficiency of vecto s as well. In addition, the spread of necrotic disease appears to be affected by soybean genotypes producing mosaic symptoms and serving as a primary inoculum source.

Soybean plants infected with SMV sometimes require indexing by local lesion assay on bean leaves because of unclear development of mosaic symptoms[2,6,10]. Therefore, the combination of a soybean cultivar and a specific virulent SMV strain resulting in necrosis of soybean can be a useful system in monitoring SMV spread to better understand its epidemiology.

摘　　要

콩 모자이크 바이러스系統 SMV-G7의 感染에 依하여 모자이크 病徵이 나타나는 함안 品種과 壞疽病徵이 나타나는 光敎를 供試하여 320.7㎡(99坪)의 圃場 中央 2.2㎡(1坪)에 함안을 播種, 接種한 後 周邊 試驗區(1坪씩 99區)에는 光敎를 播種하여 SMV의 發生生態를 調査하였다.

光敎에서 SMV罹病株率은 7月13日에 가장 甚하였고 黃色水盤으로 採集한 진딧물 密度는 6月22日에 가장 높게 나타났으며 함안과 隣接한 試驗區의 SMV罹病株率은 平均 56%, 圃場全體의 罹病株率은 平均 20.4%로 나타났다. 風向과 바이러스 罹病率을 分析한 結果 SMV의 傳播는 바람부는 쪽으로 一定한 gradient를 形成하여 SMV 傳播에 重要한 要因으로 나타났다.

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