

# Cucumber Green Mottle Mosaic Virus on Cucumber and Watermelon and Melon Necrotic Spot Virus on Muskmelon

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There are four kinds of viruses affecting plants of the cucumber family (Cucurbitaceae) in Japan: cucumber mosaic virus (CMV), watermelon mosaic virus (WMV), cucumber green mottle mosaic virus (CGMMV), and melon necrotic spot virus (MNSV).

The diseases caused by the CMV and WMV are widespread in Japan on cucumber, melon, muskmelon and pumpkin, and the annual crop losses caused by them are increasing in these years. The diseases caused by the CGMMV and MNSV occurred severely in some areas of Japan recently.

The following is a brief review of the diseases caused by the CGMMV and MNSV:

## Occurrence of CGMMV on cucumber and watermelon

### 1) Occurrence of CGMMV on cucumber

In 1966, the cucumber crop in western Japan suffered heavy losses from a virus disease. Based on host range, particle morphology, etc., the causal virus was identified as the CGMMV.<sup>2),6)</sup> Symptoms were vein-clearing, veinbanding and mosaic on leaves, and fruit malformed and showing severe mosaic (Fig. 1).

The infected fruit became commercially valueless. The damage in Tokushima Prefecture alone was said to amount 180 million yen.

The virus particle of CGMMV is rod-shaped, 300 m $\mu$  in length and 15 m $\mu$  in width (Fig. 2), and is morphologically the same as the tobacco mosaic virus (TMV). The virus is very resistant or stable as in the TMV and it persists

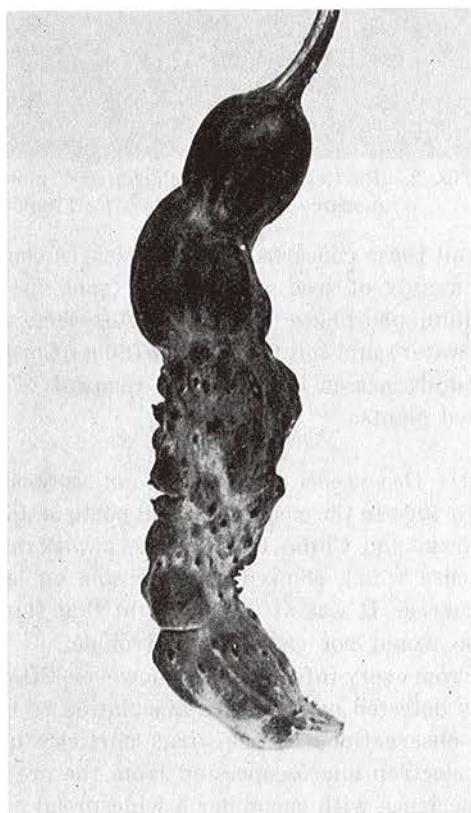


Fig. 1. Cucumber infected with cucumber green mottle mosaic virus (CGMMV).

for a long time in the soil or carried about with seeds (aphids do not transmit the virus). Because of its highly contagious nature, the epidemic on cucumber spread all over the western parts of Japan in a short time.

Since 1967, however, the disease has been arrested by thorough control measures adopted

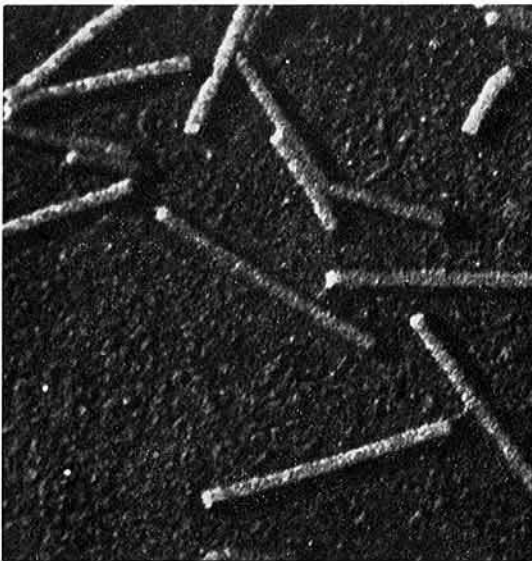


Fig. 2. Particles of cucumber green mottle mosaic virus (CGMMV) ( $\times 110,000$ ).

by all those concerned. The measures consisted mainly of seed disinfection (soak in 10% sodium phosphate for 20 minutes then wash by water) and soil fumigation (80 g of methyl-bromide per  $m^2$ ), and early removal of diseased plants.

### 2) Occurrence of CGMMV on watermelon

In 1968 in the eastern-central parts of Japan, Ibaraki and Chiba Prefectures, a watermelon disease which showed faint mosaic on leaves occurred. It was at first thought that the disease would not cause much trouble.

From every infected plant, however, CGMMV was detected by the juice inoculation test and by observations of the virus particles under an electron microscope, and from the previous experience with cucumber a widespread occurrence was checked.

Then in July, a large number of the watermelons in the same area were found to be so deteriorated that they could not be marketed. This disorder, commonly known as watermelon fruit deterioration, had been occurring to a limited extent in various cultivating areas in Japan since several decades ago and presumed to be due to a physiological disturbance.

From the findings that the occurrence sites

of this fruit deterioration coincided with those of the leaf mosaic by CGMMV, samples manifesting fruit deterioration were collected and tested for CGMMV. The result was that CGMMV was isolated from most of this fruit.

In 1969, this isolated CGMMV was inoculated on healthy watermelon plants in the glass-house as well as in the field, and the same leaf mosaic and fruit deterioration were obtained, thus confirming that CGMMV is involved as pathogen in the fruit deterioration in Chiba and Ibaraki Prefectures.<sup>4)</sup>

The characteristic symptoms of deterioration of the watermelon fruit are that some portion of the fruit meat turns to a soaked condition, manifesting a reddish purple color, and in an acute case, the meat becomes decomposed and discharges a sour smell.

More detailed descriptions of deterioration:

- 1) A part surrounding the seeds in the meat is semi-transparent and reddish purple in color, and shows a hard jelly-like texture;
- 2) In many cases, bundles of yellowish fiber-like strings are formed in the fruit meat;
- 3) White portion between the red meat and green skin becomes yellowish;
- 4) At an advanced stage, the meat becomes soft and decomposed, with central parts of the meat becoming hollow, and discharges a sour smell;
- 5) Infected fruit is low in sugar content and with a poor taste. There is an additional symptom of the disease, a dark brownish necrotic spot that appears on the stalk of the infected fruit.

### 3) Production and distribution of anti-serum

CGMMV isolated from a watermelon was purified and injected to rabbits to obtain antiserum.

In 1969, thorough control measures centering around the seed and soil disinfections were carried out in Chiba and Ibaraki Prefectures, which resulted in a drastic decline of the disease occurrence. However, in several other prefectures, the disease occurred severely in 1969. The antiserum was distributed to these prefectures and it contributed to early stage diagnoses of infected plants.

In Japan, watermelon is usually cultivated by using gourd as the root stock plant to which watermelon seedling is grafted. It was found that the seeds of the root stock gourd were infested with CGMMV at a high rate so that the disease possibly spread all over the country with gourd seeds. It is now recommended to use gourd seeds harvested from healthy plants.

#### 4) *Cucumber strain and watermelon strain of CGMMV*

The virus isolated from a watermelon at this time (later named watermelon strain) was at first thought to be the same as that isolated from cucumber (later named cucumber strain) in western Japan in 1966. With the progress of experiments, however, some differences were found between these two groups of isolates. That is, serological differences and difference in the reactions of some plants (*Chenopodium amaranticolor* and *Datura stramonium*).<sup>4)</sup>

The watermelon virus was purified and analyzed for amino acid composition of the protein part of the virus.<sup>7)</sup> The amino acid composition of the watermelon strain was found to differ from that of the cucumber strain and also that of European isolates.<sup>9)</sup> Now virus isolates have been imported from England and India to compare with the two Japanese strains in order to deduce possible invasion route of the CGMMV into Japan.

#### 5) *Bearing of CGMMV on deterioration of watermelon fruit*

The characteristic deterioration of a watermelon fruit has been observed in various areas of the country. Most of these were considered to be caused by the CGMMV. There are, however, a few cases of which the cause seems to be physiological because no CGMMV nor other viruses could be isolated. There are also cases in which CMV and or WMV but not CGMMV were isolated.<sup>4)</sup>

## Occurrence of melon necrotic spot virus (MNSV) on muskmelon

### 1) *Occurrence of the disease and its symptom*

A muskmelon disease caused by the melon necrotic spot virus has been occurring in Hamamatsu district of Shizuoka Prefecture since 1955 where muskmelon plants are grown in glass houses. From 1968 the disease has developed to an epidemic proportion, the damage amounting to 100 million yen during a single season in 1969.

Three types of symptoms were observed: 1) Numerous small necrotic spots, 1 to 2 mm in diameter, on upper leaves of the plants. At first the spots are yellowish brown, which gradually changes to grayish brown and finally to grayish white (Fig. 3). This symptom is



Fig. 3. Necrotic specks on muskmelon leaf caused by melon necrotic spot virus (MNSV).

most frequent; 2) irregular roundish brown spots of 1 to 2 cm; 3) necrosis on leaf veins and parts adjacent to veins, eventually producing a ramose pattern. When these symptoms occur, the plants die prematurely, or even when they survived they bear no fruit.

### 2) *Soil transmission of the disease*

In earlier works it was recognized that the disease is caused by a virus; transmissible by

juice inoculation; the host range is limited to the melon plant; aphid is not a vector<sup>33</sup>; and the virus particle is spherical, 30 m $\mu$  in diameter.<sup>83</sup>

Because the transmission route under natural condition was not known, it was not possible to establish effective control measures. As a result of survey and close observations of diseased plants in a glass house, it was suspected that the disease was soil-borne.

Soil samples were collected from several diseased areas and melon seeds were sown on them. One month after the sowing, roots of the melon plants showing no leaf symptoms were sampled and inoculated to test the plants (melon) by juice inoculation. The virus was detected in about 70% of the tested roots. This test showed that the virus might be transmitted through roots at a high percentage.<sup>53</sup>

Experiments since then resulted in various findings such as: (1) when melon seedlings were planted on infected soil, the virus was detected from the root 10 to 15 days after planting, (2) when infected soil was screened through a sieve, the virus content was higher in soil particles under 4 mm, and (3) when the soil was air dried, the virus could be found even after 47 days.

In soil disinfection tests, it was found steam sterilization and methylbromide or chloropicrin treatment are effective. Since the fall of 1970, the occurrence of the disease has been effectively controlled by soil disinfection by the above methods.

### 3) *Olpidium* fungus in the root of infected plant

Various studies have been made to find the major agent of transmission. A tentative conclusion at the present moment is that it is probably a fungus *Olpidium* sp. Microscopic examinations of the root of infected plants show many sporangia of the fungus inside the root<sup>53</sup> (Fig. 4). Transmission tests using this fungus are now being carried out.

The virus is thought to be related with the cucumber necrosis virus which is known to be transmitted by *Olpidium cucurbitacearum*,

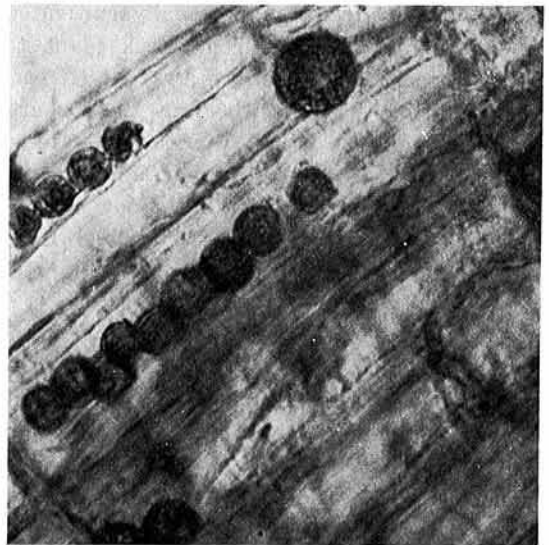


Fig. 4. Sporangia of *Olpidium* sp. observed in root tissue of muskmelon infected with melon necrotic spot virus (MNSV) ( $\times 600$ ).

as reported in Canada,<sup>13</sup> although there are some differences in host range and serological properties between these viruses.

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