

## STUDY THE EFFECT OF *Cucumber mosaic virus* (CMV) ON DIFFERENT GROWTH STAGES OF CHILI

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### Abstract

A field experiment was conducted during winter 2011-12 to examine the effect of *Cucumber mosaic virus* (CMV) infection on growth and yield attributes of chili at different plant growth stages. Significant variation was observed in CMV incidence as well as growth and yield attributes among ten chili genotypes at different growth stages. Although the highest disease incidence was found at late plant growth stage followed by mid and early stages, the maximum reduction in plant height and canopy diameter was recorded at early stage. Similarly, the minimum reduction in fruit number per plant, fruit length and fruit weight was observed at late stage infection by CMV, while the maximum reduction in these parameters was recorded at early stage infection. The results indicate that CMV infection at early stage of plant growth is destructive in reducing growth and yield attributes in chili. These findings may help to design effective management practices to reduce the negative effect of CMV disease in chili.

**Key words:** CMV, Chili, Effect, Growth and Yield reduction.

### Introduction

Chili (*Capsicum* spp.), is an important vegetable and spice crop having immense commercial importance. Among the five cultivated species of the genus *Capsicum* *annuum* is the most widely cultivated in Bangladesh for its pungent (Chili Syn. hot Pepper) and non-pungent (Sweet pepper Syn. Casicum, bell pepper) fruits. Chili is infected with several fungal, viral and bacterial diseases which incite severe economic losses. Among them anthracnose (*Colletotrichum* spp.), Cercospora leaf spot (*Cercospora capsici*), Phytophthora blight (*Phytophthora capsici*), bacterial wilt (*Ralstonia solanacearum*), bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*), Fusarium wilt (*Fusarium oxysporum*), aphid-transmitted viruses like *Chili vein mottle virus* (ChiVMV), *Chili leaf curl virus* (CLCV), *Cucumber mosaic virus*

(CMV), *Potato virus Y* (PVY), *Tobamoviruses* like *Tobacco mosaic virus* (TMV), *Tomato mosaic virus* (ToMV); and *Potato mild mottle virus* (PMMV) are the major diseases infecting chilli worldwide (Berke *et al.*, 2005).

Viruses are responsible for huge losses in crop production and quality all over the world. Due to worldwide distribution and polyphagous vectors, *Cucumber mosaic virus* (CMV) is one of the most important virus infecting vegetable species worldwide (Montasser *et al.* 1998; Palukaitis and Garcia-Arenal, 2003; Pakdeevaporn *et al.* 2005; Biswas *et al.* 2013). However, in Asia, CMV is particularly severe on chilli (Green, 1993). In chilli peppers CMV can causes up to 41% yield losses (Joshi and Dubey, 1973). Further, yield losses of more than 60% from CMV have been reported in peppers (Florini and Zitter, 1987). In case of early infection yield losses may range from

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60-100 % (Singh and Cheema, 1989; Shukor *et al.*, 1989). CMV may reduce the quality of fruits (Palukaitis, 1992; Green and Kim, 1991; Rahman, 2008).

Transmission of CMV occurs through multiple means. More than 80 species of aphids including the green peach aphid, *Myzus persicae*, are a vector of CMV. According to Cerkauskas *et al.* (2004) *Cucumber mosaic virus* (CMV) is not transmitted through pepper seed. CMV can be mechanically transmitted but because it is not as stable as TMV, workers handling infected pepper plants do not as readily transmit it. Weeds are hosts for the virus as well as for the aphid vectors. The large number of aphid vector species and natural host reservoirs accounts for the high incidence of CMV in field plants.

CMV is considered as devastating virus on chili in Bangladesh in respect of yield and quality deterioration. The amount of crop losses due to depends on the strain of the virus, vegetable variety, the age of the plant, climatic factors viral disease during disease development etc. (Thackray *et al.*, 2004). The stage of host plant in which the disease can cause maximum yield loss in the crop and proper disease loss assessment is urgently needed for appropriate management of diseases. Furthermore, there are few works have been done in this regards. The present study was undertaken to find out the yield loss due to CMV in different growth stages of chili.

### Materials and Methods

The experiment was conducted during winter 2011-12. Ten genotypes namely Khulna (CA1), Manikgonj (CA2), Bogra (CA6), BARI-1 (CA8), Comilla-2 (CA12), Comilla-1(CA15), Kushtia (CA19), Rangpur (CA20), Noakhali (CA23) and Pusa Jawla (CA24) were used in this study. Seeds were collected from Spices Research Center (SRC) of Bangladesh Agriculture Research Institute (BARI), Gazipur and Department

of Plant Pathology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU). The experimental field was ploughed mechanically and leveled to have a good tilth. Fertilizer doses were used as Urea-210, TSP-300, MP-200, and Gypsum-110 kg/ha as suggested by Spices Research Centre, Bangladesh Agricultural Research Institute (Anon. 2005). Cow-dung was used at the rate of 10 t/ha. Seedlings were raised in the seedbed and 40 day old healthy looking seedlings were transplanted in the 1<sup>st</sup> week of December with a spacing of 40×50 cm. Irrigation, drainage, weeding and other intercultural operations were done as and when necessary. However, no plant protection measures were undertaken. Plants showing symptoms of CMV were tagged and data were recorded from the tagged plants. Initially the virus diseases were identified on the basis of Symptomatological study (Green and Kalloo 1994). Later, it was confirmed by a commercially available CMV Diagnostic Kit (NEOGEN Europe Ltd. UK). The protocol was followed according to manufacturer's recommendations. The absorbance values (405 nm) were measured with an automatic ELISA reader (MRX microplate reader, Dynex Magellan Biosciences, USA). Samples were considered positive for CMV infection when the ELISA absorbance value was greater than the average absorbance value of healthy tissue as well as negative control. Commercial positive and negative controls were included in CMV ELISA kit.

CMV infection was confirmed by DAS-ELISA. Growth and yield attributes of the genotypes were also recorded to compare with apparently healthy plants. Reduction in growth, yield attributes and yield was calculated using the following formula:

$$R = \frac{Y - Y_1}{Y} \times 100$$

Where,

R = Percent reduction of growth and yield contributing character

Y = Growth and yield contributing characters of healthy plants

$Y_1$  = Growth and yield contributing characters of infected plants

Disease incidence and plant growth were recorded at three different growth stages; early stage (5 weeks after transplanting), mid stage (5 weeks after early stage) and late stage (following mid stage to harvest).

The experiment was laid out in a randomized complete block design (RCBD) with four replications. Each plot consisted of twenty five plants. Data were analyzed by analysis of variance (ANOVA) using MSTAT-C program and means were compared according to Duncan's Multiple Range Test (Gomez and Gomez 1984). Percent data were transformed in accordance with arcsine transformation before analysis.

## Results and Discussion

**Incidence of CMV:** CMV incidence on various genotypes at different growth stages are presented in figure 1. Considerable variation of disease incidence was found at different growth stages of chilli genotypes. In all cases, late incidence was higher followed by mid and early, irrespective of genotypes. In early stage, apparently no incidence was observed in CA23 and the highest was found 16.75% in CA20. In mid stage, the highest incidence (20.00 %) was found in CA20 and the lowest in CA23 (2.51%). In late stage, incidence ranged from 8.75 % to 25.00% and the highest was observed in CA1 and the lowest was found in CA23. Considering the incidence of CMV in different growth stages of genotypes, it was revealed that higher incidence occurred at the later growth stage than earlier ones. It might be due to the early infected plants act as primary sources of virus and the virus get more time to infect

the plants. The genotype CA23 performed better among the genotypes tested in respect of CMV incidence. Our results revealed that majority of the genotypes showed susceptible reaction to CMV, while the source of CMV resistance is not very common.

## Effect of *Cucumber mosaic virus* on growth attributes of chili

**Plant height:** The highest reduction in plant height was observed at early stage followed by mid and late stages irrespective of genotypes (Table 1). At early infection, the highest plant height reduction (50.89%) was found in CA1 and no reduction was found in CA23. Because, CA23 was apparently free from early infection. At mid stage, the highest (30.56 %) plant height reduction was found in CA20 and the lowest in CA23 (7.74 %). However, at late stage, the plant height reduction was not varied significantly among the genotypes tested. The present investigation suggested that early infection is more destructive than mid and late infection to reduce plant height. The present result is in conformity with the findings of Singh and Cheema (1989) and Shukor *et al.* (1989) who also reported similar effect of plant growth stage.

## Canopy diameter

Data on effect of CMV on canopy diameter of chili genotypes at different growth stages are presented in Table 2. The highest canopy diameter reduction was observed in CA6 (51.48%) and no reduction was found in CA23 at early stage infection. Canopy diameter reduction ranged from 7.55 to 27.49% at mid stage infection. The highest reduction was found in genotypes CA19 (27.49%) and the lowest reduction was observed in CA23 (7.55%). At late stage, canopy diameter reduction was found between 8.87 and 13.23%. The result revealed that early stage infection of CMV is more deleterious to canopy growth than other growth stages. It might be due to

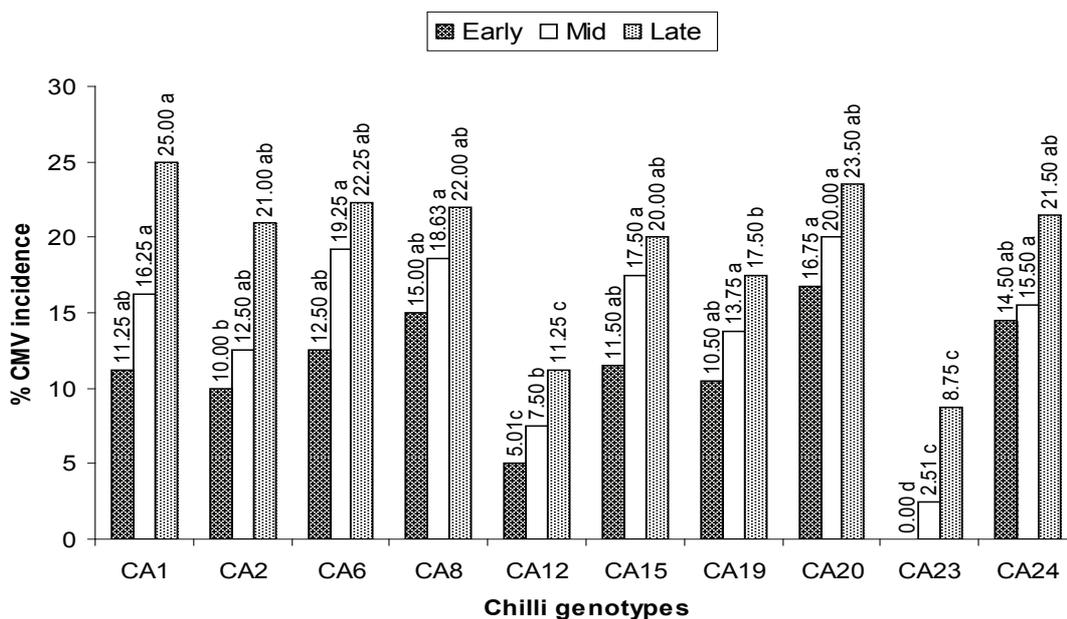


Figure 1. Incidence of CMV at different growth (early, mid and late) stages of chilli genotypes. Means followed by same letters on top of the bars are not significantly different at 5% level by DMRT. CA1 (Khulna), CA2 (Manikgonj), CA6 (Bogra), CA8 (BARI-1), CA12 (Comilla-2), CA15 (Comilla-1), CA19 (Kushtia), CA20 (Rangpur), CA23 (Noakhali), CA24 (Pusa Jawla).

**Table 1 Effect of CMV infection on plant height of chili plants at three different growth stages.**

Genotype	Plant height reduction (%)		
	Early stage	Mid stage	Late stage
CA1 (Khulna)	50.89 a (45.51)	28.95 a (32.54)	12.26 a (20.47)
CA2 (Manikgonj)	43.61 b (41.33)	22.28 abc (28.11)	12.72 a (20.78)
CA6 (Bogra)	47.28 ab (43.43)	25.72 ab (30.45)	12.48 a (20.65)
CA8 (BARI Marich-1)	39.15 b (38.71)	18.10 bc (25.16)	9.95 a (18.35)
CA12 (Comilla-2)	39.68 b (39.04)	24.29 ab (29.53)	9.52 a (17.86)
CA15 (Comilla-1)	39.63 b (39.00)	14.79 c (22.55)	9.98 a (18.34)
CA19 (Kushtia)	38.50 b (38.26)	17.49 bc (24.59)	10.70 a (19.02)
CA20 (Rangpur)	50.43 a (45.24)	30.59 a (33.56)	12.17 a (20.29)
CA23 (Noakhali)	0.00 c (0.640)	7.74 d (16.04)	6.07 a (8.84)
CA24 (Pusa Jawla)	50.73 a (45.55)	26.66 a (31.07)	12.10 a (20.27)ns
CV	11.13 %	18.82 %	12.77 %

\*Means followed by same letters in row and column are not significantly different at 5% level by DMRT. Figures in parenthesis are arcsine transformed values..

imbalance in growth regulators due to CMV infection. Consequently, plant could not expand and canopy diameter was smaller in CMV infected plants.

### **Effect of *Cucumber mosaic virus* on yield attributes of chili**

**Fruit per plant:** Reduction in fruit number per plant of chili genotypes at different growth stages due to CMV infection are presented in Table 3. Fruit number per plant was found to be reduced at all the growth stages of CMV-infected chili plants. The highest reduction (80.18 %) was observed at early stage in CA20 which was followed by CA19 (77.14%), CA8 (73.34%), CA24 (73.19%), CA6 (71.77%) and CA15 (71.32%). No reduction in fruit/plant was observed in CA23. At mid stage infection, the highest reduction (50.03%) of fruit/plant was observed in CA20 which was followed by CA19 (48.12%), CA24 (44.54%), CA15 (43.67%), CA6 (43.16%), CA1 (41.71%) and CA8 (41.07%) and the lowest in CA23 (7.11%). At late stage infection, fruit number reduction ranged from 6.27 to 12.51 %. Results of present investigation demonstrated that early stage infection of CMV is more destructive to fruit number per plant than other stages. The findings are in agreement with the earlier findings of Singh and Cheema (1989) and Shukor *et al.* (1989) who also reported 60 to 100% yield losses due to viral infection at early stage of plant growth.

### **Fruit length and weight**

Fruit length reduction due to CMV infection at different growth stages of chili genotypes are presented in Table 4. Significant fruit length reduction was observed due to CMV infection at all growth stages in chili genotypes. At early stage, fruit length reduction ranged from 0.00 to 45.81%. The highest fruit length reduction (45.81%) was found in genotypes CA20 which was statistically similar to CA24 (42.43%), CA1 (40.48%), CA19 (39.45%)

and CA6 (39.83%) (Table 4). Genotype CA23 was free from CMV infection at early growth stage of plants and no effect on fruit length was observed in this genotype. At mid stage, all genotypes showed more or less similar reduction of fruit length except genotypes CA12 and CA23. Here the fruit length reduction was ranged 10.37 to 29.44%. The highest fruit length reduction was observed in CA6 and the lowest in CA23. At late stage, fruit length reduction ranged from 7.10 to 26.24%. The highest reduction was recorded in CA8 and the lowest in CA23.

Similarly, at early growth stage, the highest fruit weight reduction of 60.97% was recorded in CA1 which was followed by CA6 (57.75%). No effect of CMV infection on fruit weight was observed in CA23 as the genotype was free from CMV infection. In case of mid infection, the highest fruit weight reduction was also found in CA1 (48.29%) which was statistically similar to CA20 (45.04%). The lowest infection was found in CA23 (6.31%). Other genotypes showed more or less similar fruit weight reduction. Minimum fruit weight reduction was observed at late growth stage infection ranging from 7.59 to 22.33 % (Table 5). Results of the present investigation reveal similar effect that early infection of CMV caused maximum reduction in fruit length and weight in chili.

In conclusion, significant variation was observed in CMV incidence as well as growth and yield attributes among ten chili genotypes at different growth stages. Although the highest disease incidence was found at late plant growth stage followed by mid and early stages, the maximum reduction in plant height and canopy diameter was recorded at early stage. Similarly, the minimum reduction in fruit number per plant, fruit length and fruit weight was observed at late stage infection by CMV, while the maximum reduction in these parameters was recorded at early stage infection. The results indicate that CMV

**Table 2 Effect of CMV infection on canopy diameter of chili plants at three different growth stages.**

Genotype	Canopy diameter reduction (%)		
	Early stage	Mid stage	Late stage
CA1 (Khulna)	48.61ab (44.20)	19.16 a (25.92)	13.23 ns (21.24)
CA2 (Manikgonj)	47.64 abc (43.64)	21.18 a (27.39)	12.58 (20.67)
CA6 (Bogra)	51.48 a (45.85)	24.96 a (29.94)	10.52 (18.90)
CA8 (BARI Marich-1)	36.37 d (36.97)	23.65 a (29.08)	10.17 (18.56)
CA12 (Comilla-2)	38.59 bcd (38.39)	19.75 a (26.34)	10.25 (18.60)
CA15 (Comilla-1)	44.62 a-d (41.91)	21.51 a (27.55)	11.56 (19.69)
CA19 (Kushtia)	45.93 a-d (42.65)	27.49 a (31.56)	10.19 (18.60)
CA20 (Rangpur)	42.70 a-d (40.78)	22.74 a (28.45)	13.28 (21.34)
CA23 (Noakhali)	0.00 e (0.64)	7.55 b (9.90)	8.87 (17.28)
CA24 (Pusa Jawla)	37.34 cd (37.62)	26.72 a (31.11)	11.381 (19.57)
CV	8.60%	20.38%	12.30%

\*Means followed by same letters in the same column are not significantly different at 5% level by DMRT. Figures in parenthesis are arcsine transformed values.

**Table 3 Effect of CMV infection on number of fruit per plant in different chili genotypes at three different plant growth stages.**

Genotype	Fruit number reduction (%) due to CMV infection		
	Early stage	Mid stage	Late stage
CA1 (Khulna)	69.34 bc (56.40)	41.71 abc (40.20)	10.86 a (18.99)
CA2 (Manikgonj)	69.15 bc (56.29)	40.38 bc (39.44)	09.85 ab (18.24)
CA6 (Bogra)	71.77 abc (57.95)	43.16 abc (41.06)	12.10 a (20.12)
CA8 (BARI Marich-1)	73.34 ab (59.09)	41.07 abc (39.85)	10.30 ab (18.59)
CA12 (Comilla-2)	62.35 c (52.26)	35.72 c (36.67)	10.40 ab (18.75)
CA15 (Comilla-1)	71.32 abc (57.68)	43.67 abc (41.35)	09.65 ab (17.94)
CA19 (Kushtia)	77.14 ab (61.47)	48.12 ab (43.92)	10.23 ab (18.61)
CA20 (Rangpur)	80.18 a (63.57)	50.03 a (45.02)	12.24 a (20.34)
CA23 (Noakhali)	0.00 d (0.64)	07.11 c (15.32)	6.27 b (8.99)
CA24 (Pusa Jawla)	73.19 ab (58.87)	44.54 abc (41.86)	12.51 a (20.63)
CV	6.21 %	12.76 %	9.55 %

\*Means followed by same letters in the same column are not significantly different at 5% level by DMRT. Figures in parenthesis are arcsine transformed values.

**Table 4 Effect of CMV infection on fruit length of chili plants at three different growth stages.**

Genotype	Fruit length reduction (%)		
	Early stage	Mid stage	Late stage
CA1 (Khulna)	40.48 ab (39.49)	26.68 a (31.07)	24.54 a (29.66)
CA2 (Manikgonj)	34.54 bc (35.82)	19.99 ab (26.46)	17.38 abc (24.54)
CA6 (Bogra)	39.83 ab (39.10)	29.44 a (32.82)	24.72 a (29.77)
CA8 (BARI Marich-1)	36.18 bc (36.97)	26.24 a (30.81)	26.24 a (30.81)
CA12 (Comilla-2)	27.47 c (31.60)	15.78 bc (23.36)	14.38 bc (22.22)
CA15 (Comilla-1)	34.57 bc (36.01)	23.10 ab (28.67)	23.09 ab (28.67)
CA19 (Kushtia)	39.45 ab (38.88)	28.38 a (32.15)	23.56 a (29.03)
CA20 (Rangpur)	45.81 a (42.60)	28.87 a (32.49)	24.90 a (29.87)
CA23 (Noakhali)	0.00 d (0.64)	10.37 c (18.67)	7.10 c (9.61)
CA24 (Pusa Jawla)	42.43 ab (40.64)	28.26 a (32.07)	12.54 c (19.84)
CV	9.23%	19.59%	13.67%

\*Means followed by same letters in the same column are not significantly different at 5% level by DMRT. Figures in parenthesis are arcsine transformed values.

**Table 5 Effect of CMV infection on fruit weight of chili plants at three different growth stages.**

Genotype	Fruit weight reduction (%)		
	Early stage	Mid stage	Late stage
CA1 (Khulna)	60.97 a (51.35)	48.29 a (44.02)	18.29ab (25.21)
CA2 (Manikgonj)	52.21 c (46.28)	27.12 bc (31.37)	16.66 ab (23.91)
CA6 (Bogra)	57.75 ab (49.46)	31.02 b (33.55)	22.33 a (28.16)
CA8 (BARI Marich-1)	53.10 bc (46.78)	22.24 bc (27.82)	13.01 bcd (21.09)
CA12 (Comilla-2)	41.33 d (39.99)	14.95 cd (22.70)	09.78 cd (18.20)
CA15 (Comilla-1)	54.66 bc (47.68)	29.65 b (32.95)	21.33 a (27.29)
CA19 (Kushtia)	51.21 c (45.70)	29.20 b (32.71)	19.19 ab (25.94)
CA20 (Rangpur)	52.47 c (46.42)	45.04 a (42.15)	24.24 a (29.43)
CA23 (Noakhali)	0.00 e (0.64)	6.31 d (9.02)	07.59 d (15.87)
CA24 (Pusa Jawla)	53.90 bc (47.24)	24.85 bc (29.78)	16.14 abc (23.55)
CV	5.81 %	19.75 %	12.88 %

\*Means followed by same letters in the same column are not significantly different at 5% level by DMRT. Figures in parenthesis are arcsine transformed values.

infection at early stage of plant growth is destructive in reducing growth and yield attributes in chili. These findings may help to design effective management practices to reduce the negative effect of CMV disease in chili.

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