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INFLUENCE OF FERTILIZER APPLICATION ON THE GROWTH RESPONSE OF CELOSIA ARGENTEA INFECTED WITH TWO VIRUSES

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Abstract

A greenhouse study was conducted to evaluate the influence of fertilizer application on the growth response of *Celosia argentea* mechanically infected with *Cucumber mosaic virus* (CMV) and *Okra mosaic virus* (OKMV). Four seeds and later thinned to two stands of the vegetable were sown per 10-litre sized plastic buckets filled with sandy-loam soil steam-sterilized at 12 °C for 1 hour. Fertilizer application was at the rate of 3 g (N-P-K 15-15-15) applied to 10 Kg soil prior sowing. CMV and OKMV virus isolates were inoculated on the vegetable grown on the fertilized and non-fertilized soils at 14 days after planting. The results of the experiment revealed that disease severity was generally lower in the fertilized plants. Virus inoculation also indicated increasing pathogenicity of CMV (35.8 % - 68.4 %) and OKMV (24.1 % - 64.4 %). However, irrespective of the virus inoculum, the combined effect of fertilizer application and virus inoculation resulted in lower disease severity [CMV (35.6 % - 61.0 %) and OKMV (32.2 % - 59.3 %)] as compared with the effect of the non - application of fertilizer and virus inoculation [CMV (35.7 % - 77.9 %) and OKMV (35.9 % - 74.0 %)]. The effect of treatment on growth parameters also followed the same trend. The effect on shoot weight showed that fertilizer application at the rate of 3 g per 10 Kg soil produced a significantly higher shoot weight per plant (2.8 g) compared to non - fertilizer application (1.8 g). The results obtained from this study are indicative of the potential use of soil-nutrient augmentation as management for *C. argentea* virus diseases. This procedure if properly adopted could increase production with an attendant reduction in hunger and poverty among vegetable farmers in Nigeria.

Keywords: *Celosia argentea*, Fertilizer, Inoculation, Pathogenicity, Virus

Introduction

Celosia argentea L., known also as Lagos spinach, is an edible, leaf vegetable crop of the genus *Celosia* belonging to the family Amaranthaceae (Badra, 1991). It is an erect, short-lived annual herb, which grows up to 150 cm in height. The leaves are alternate and are light green to dark green in the green

forms (Sterrett and Savange, 1989). The wide diversity of *Celosia argentea* in tropical Africa points to an origin of the crop in this region and it is indeed one of the leading leaf vegetables in South Western Nigeria (Olaniyi and Ojetayo, 2012).

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C. argentea has a very high nutritive value, and both the grain and the leaf is widely used and processed into many food items, supplements and additives (Akingbala *et al.*, 1994). The vegetable is accredited with possession of high nutritional values of essential nutrients like calcium, phosphorous, iron and other important components such as vitamins C, fiber, carbohydrate, fat and a high calorific value (Akinfasoye *et al.*, 2008).

The effect of many nutrients on disease has been observed incidentally as a consequence of fertilizing to optimize plant growth or yield, and then confirming the observations under more controlled conditions in the greenhouse or field (Huber and Haneklaus, 2007). Vegetable cropping systems are strongly influenced by fertilizer application and require greater degree of management than most agronomic cropping systems (Grubben and Denton, 2004). Fertilizer application can produce a means of using nutrients to reduce the severity of many diseases that affect plants (Oborn *et al.*, 2003). Studies by Marschner (1995) and Huber and Graham (1999), indicate the importance of fertilizer application in the management of some plant diseases to attain optimum yield.

C. argentea is susceptible to pathogens which cause fungal, nematode, bacterial, and viral diseases (Broadbent *et al.* 1977, Caveness and Wilson 1977; Nyamupingidza and Machakaire, 2003). Viruses cause diseases in several hundred *C. argentea* species, with various symptoms, collectively referred to as yellows diseases (McCoy *et al.*, 1989). They are transmitted by insect vectors and over 50 different viruses belonging to 21 groups have been found in celosia (Cohen *et al.*, 2000). In an experiment carried out in a southern guinea savannah agro-ecological zone of Nigeria, Aliyu *et al.* (2014) found *C. argentea* to be susceptible to infections by *Cucumber mosaic virus* (CMV) and *Bitterleaf mosaic virus* (BLMV) in. The researchers in the

study thus advocated for the need for an effective and sustainable control of viruses to increase productivity of the vegetable.

Nutrients are essential elements for good and supportive plant growth and are also implicated in disease reduction to levels at which further control by other practices is more successful and less expensive. In spite of this, the manipulation of plant nutrient requirement for virus disease control in vegetables especially *C. argentea* has received very little attention. Furthermore, the conventional use of synthetic pesticides in pathogenic disease management is associated with a myriad of food safety and environmental concerns. Consequently, a greenhouse experiment was conducted to evaluate the influence of fertilizer application on the growth response of *Celosea argentea* infected with *Cucumber mosaic virus* (CMV) and *Okra mosaic virus* (OKMV).

MATERIALS AND METHODS

Source of seeds

The seeds of a local variety of *Celosia argentea* (TLV 8, Purple and Local) were obtained from the Horticultural Division of the parks and gardens, University of Ilorin-Nigeria. Four seeds were sown per 10-litre sized (50 cm diameter) plastic buckets filled with sandy-loam soil that was previously steam-sterilized at 121°C for 60 minutes and the plants were later thinned to two plants per plastic bucket after germination prior inoculation with the virus. Fertilizer application to the treatment pots was at the rate of 3 g N.P.K fertilizer per 10 Kg soil incorporated to the soil just prior to the sowing of seeds.

Source of inoculums and inoculation procedure

The viral isolates *Cucumber mosaic virus* (CMV) and *Okra mosaic virus* (OKMV), were sourced from the International Institute of Tropical Agriculture Ibadan-Nigeria

(IITA). The viruses were isolated from infected leaf samples by the process of homogenization. This was achieved by macerating the infected leaf samples using mortar and pestle in 0.01 M phosphate buffer (Africa Biosciences Limited, Ibadan-Nigeria) at pH 7.2 at the rate of 1g leaf sample to 5 ml of buffer according to the method of Balogun and Aliyu (2005).

One part virus infected tissue was ground up in a small mortar with 2 to 5 parts buffer, generally 0.01M phosphate buffer, pH 7.2. The inoculum was kept cool and used immediately. The buffer was prepared in the following way: Solution A: 1.36 g KH_2PO_4 in 1000 ml H_2O Solution B: 1.78 g $\text{Na}_2\text{V-P0}_4 \times 2 \text{H}_2\text{O}$ in 1000 ml H_2O . 51.0 ml of solution B mixed with 49.0 ml of solution A gives 100 ml of 0.01 M phosphate buffer solution pH 7.2 (Noordam, 1973).

The plants were inoculated at 14 days after planting at the 2nd leaf stage in the mid-afternoon when the plants are more susceptible. The procedure of inoculation was by slight dusting of the primary leaves with Carborundum (silicon carbide, 400-600 mesh) and Celite (diatomaceous earth) to increase infection by providing wounds for the entry of virus particles. The abrasive was finely dusted over the leaf surface and also suspended in the inoculum (0.5-1% w/v) before inoculation after which the leaves were then rubbed with the extracted juice of the inoculum, using cotton wool.

The inoculation was carried out by moistening 1 or 2 fingers in inoculum and rubbing gently onto the leaves, while supporting them with the other hand. The plants were thereafter rinsed with distilled water thereafter to reduce inoculation stress. The plants that served as control for the experiment were buffer inoculated for the fertilized and non-fertilized soils (Balogun, 2000).

Experimental design

The experiment was a Factorial fitted into a Randomized Complete Block Design (RCBD) with the plots laid 0.5 m apart on the greenhouse table (1 m above ground level). The pots were constantly supplied with fresh tap water in the evenings until maturity. The six treatments for the study were: CMV inoculated plants in fertilized soil, OKMV inoculated plants in fertilized soil, CMV inoculated plants in non-fertilized soil, OKMV inoculated plants in non-fertilized soil, buffer inoculated plants in fertilized soil and buffer inoculated plants in non-fertilized soil. The treatments were replicated thrice and conducted at a temperature of $24 \pm 2^\circ\text{C}$, Relative Humidity $60 \pm 5\%$ and 12 hours sunlight.

Data collection

Data were recorded on weekly basis from the 3rd to the 9th week after inoculation for plant height, number of leaves per plant, number of leaves with viral disease symptoms, stem girth, number of pods per plant and seed weight. The percentage disease severity was by using a modified formula-grading scheme of Merritt, *et al.*, (1999) and was measured by the number of leaves with viral disease symptoms relative to the total number of leaves on any given plant.

Statistical analysis

All collected data were subjected to analysis of variance (ANOVA) using the statistical package for the social sciences SPSS version 15.0. The treatment means where significant, were separated using the New Duncan Multiple Range Test at 5 % level of probability.

RESULTS

Effect of treatments on disease severity

Table 1 shows the effect of fertilizer application and virus inoculation on mean percentage severity of disease from 3rd to the

9th week after inoculation (W.A.I). The effect of fertilizer application indicated that although disease severity was generally lower in the fertilized plants, the values were not significantly different from the non-fertilized plants. Viral inoculation result also showed that CMV was more pathogenic (35.8 % - 68.4 %) compared to OKMV (24.1 % - 64.4 %) and these values were significantly higher than in the buffer inoculated plants which had no infection.

The effect of fertilizer application with inoculation indicated that there were significant differences between the treatments. Irrespective of the virus inoculated, the effect of fertilizer application and virus inoculation, resulted in lower disease severity in CMV (35.6% - 61.0 %) and OKMV (32.2% - 59.3 %) compared to the non - application of fertilizer and virus inoculation with CMV (35.7 % - 77.9 %) and OKMV (35.9 % - 74.0 %).

Effect of treatments on plant height

Table 2 presents the effect of the treatments on plant height at different times after inoculation. Fertilizer application was of significant effect from 4th - 9th W.A.I. The significantly tallest plants were in the fertilized plants (33.1 cm - 88.2cm) against the non-fertilized plants (33.0 cm - 56.6cm). The effect of inoculum indicated that virus inoculated plants were significantly shortest from the 7th to the 9th W.A.I. OKMV and CMV inoculated plants averaged between 30.0cm - 64.1cm and 30.9cm - 64.3cm respectively.

Assessment from the 4th W.A.I of effect of fertilizer application combined virus inoculation indicated that the buffer inoculated and fertilized plants were the significantly tallest (55.4cm - 106.1cm), followed by the buffer inoculated with non-fertilized plants (46.9 cm - 80.4 cm). The heights of plants fertilized and also inoculated with CMV (35.2 cm - 63.9 cm) and OKMV (38.2cm - 75.1cm) and the fertilized plus non-inoculated plants for

CMV (30.1 cm - 56.0 cm) and OKMV (31.2 cm - 60.2 cm) were significantly lower than the control treatments.

Effect of treatments on mean number of leaves

The effect of treatments on mean number of leaves of celosia at different times after inoculation is highlighted in Table 3. It is shown that from the 4th - 9th W.A.I, the effect of fertilizer application was significantly higher (23.1 - 38.3) than non-fertilizer application (15.1 - 23.0). Virus inoculation however had no significant effect on mean number of leaves per plant. The combination effect of the treatments indicated that the buffer inoculation and fertilizer application of plants produced the significantly highest number of leaves (22.0 - 46.0). The effect of fertilizer application and inoculation was also not significantly different except at the 4th and 9th W.A.I in the non-fertilized plus virus inoculation.

Effect of treatments on stem girth

Table 4 shows that fertilizer application on the plants resulted in the significantly widest stem girths (1.0 cm - 1.9 cm) compared to non-fertilizer application (0.8 cm - 1.3 cm). CMV inoculation (0.7 cm - 1.4 cm) also had the most reducing effect on stem girth compared to OKMV (0.9 cm - 1.5 cm). The buffer inoculated (control) plants formed the highest girths (1.1 cm - 1.9 cm). The combination effect of the treatments also showed significant differences in stem girth. However in most cases the fertilized control plants had the highest values, while the non-fertilized plus virus inoculated plants generally manifested the lowest stem girths.

Effect of treatments on fresh shoot weight

The effect of treatments on fresh shoot weight (g) per plant of celosia at harvest is presented in Table 5. The table indicates that fertilizer application produced a significantly higher shoot weight per plant (2.8 g) compared to non-fertilizer

application (1.8 g). The effect of virus inoculation also significantly reduced fresh shoot weight in CMV (1.5 g) and OKMV (1.4 g); while the buffer inoculated plants (control) had the significantly highest per plant fresh shoot weight (2.4 g).

The effect of fertilizer and inoculum on fresh shoot weight indicated that the control with fertilized plants produced the highest weights (2.7 g) per plant. The non – fertilized plus OKMV and CMV inoculated plants had the significantly lowest fresh shoot weights of 1.2 g and 1.1g respectively. These values were also significantly lower than the fresh shoot weights obtained in the fertilized plus OKMV (1.6 g) and CMV (1.5 g) inoculated plants.

DISCUSSION

Results from this study infer that fertilizer application positively influenced the growth, yield response and lower disease severity of *Celosia argentea* plants inoculated with *cowpea mosaic virus* and *okra mosaic virus*. This report is similar to Fajinmi and Odebode, (2007) who reported similar findings with pepper. It was observed in the study that pepper varieties fertilized with poultry organic manure, though infected with Pepper Veinal Mottle Virus (PVMV), had better reduction in PVMV disease incidence and severity and an increased fruit yield compared with the unfertilized infected varieties. The significant reduction effect in the PVMV disease severity was concluded to be due to the availability of constant slow release of required nutrient to the plant, which facilitated improvement in vigor of the pepper plant to develop tolerance to the PVMV infection. The same assumption can be made in the present study that the level of tolerance exhibited by *C. argentea* to the virus infection resulted from additional nutrition obtained from the applied N.P.K. fertilizer. This is also supported by Howard *et al.* (1999) that plants suffering a nutrient stress will be less vigorous and more susceptible to a variety

of diseases. It also in agreement with the views of Agrios (2005), Vidhyasekaran (2004) and Walters and Bingha, (2007) that fertilizer application to plants can increase resistance or tolerance to pathogens.

CONCLUSION

Plant nutrition is a critical component of virus disease management for optimal yields in *C. argentea* cultivation. Soil augmentation at the rate of 3 g N.P.K (15 - 15-15) fertilizer per 100 kg soil in greenhouse conditions was found successful in ameliorating *Cucumber mosaic virus* (CMV) and *Okra mosaic virus* (OKMV) disease in *C. argentea*.

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Table 1: Effect of Fertilizer application and Virus inoculation on disease severity

<u>TREATMENTS</u>	<u>WEEKS AFTER INOCULATION</u>						
	<u>Wk 3</u>	<u>Wk 4</u>	<u>Wk 5</u>	<u>Wk 6</u>	<u>Wk 7</u>	<u>Wk 8</u>	<u>Wk 9</u>
<u>Fertilizer App.</u>							
Fertilizer ⁺	17.2	27.4	37.8	37.9	37.3	39.9	41.4
Fertilizer ⁻	22.7	36.1	40.7	46.1	44.4	41.5	44.5
	ns	ns	ns	ns	ns	ns	ns
S.E	6.040	9.599	5.428	9.035	7.406	4.856	5.974
<u>Inoculum</u>							
CMV ⁺	35.8 ^a	48.2 ^a	61.2 ^a	64.4 ^a	66.2 ^a	67.3 ^a	68.4 ^a
OKMV ⁺	24.1 ^a	47.1 ^a	58.0 ^a	60.9 ^a	62.3 ^a	63.8 ^a	64.4 ^a
Control (Buffer)	0.0 ^b	0.0 ^b	0.0 ^b	0.0 ^b	0.0 ^b	0.0 ^b	0.0 ^b
S.E	4.947	9.307	1.749	3.717	1.722	2.273	1.193
<u>Fert. X Inoc.</u>							
F ⁺ X CMV	35.6 ^a	54.8 ^b	57.7 ^c	58.7 ^b	57.4 ^b	60.2 ^c	61.0 ^c
F ⁺ X OKMV	32.2 ^a	53.6 ^b	64.5 ^b	53.6 ^b	54.4 ^b	57.5 ^d	59.3 ^c
F ⁻ X CMV	35.7 ^a	60.6 ^a	66.7 ^a	70.1 ^a	75.1 ^a	77.2 ^a	77.9 ^a
F ⁻ X OKMV	35.9 ^a	58.9 ^a	68.2 ^a	69.2 ^a	70.2 ^a	73.6 ^b	74.0 ^b
F ⁺ Control	0.0 ^b	0.0 ^c	0.0 ^d	0.0 ^c	0.0 ^c	0.0 ^e	0.0 ^d
F ⁻ Control	0.0 ^b	0.0 ^c	0.0 ^d	0.0 ^c	0.0 ^c	0.0 ^e	0.0 ^d
S.E	6.997	13.161	2.473	5.257	2.436	3.214	1.688

Means within a column followed by the same letter(s) are not significantly different using the New Duncan multiple Range Test at P > 0.05

Key: INOC. = Inoculation ns = not significant, Fertilizer⁺ = Fertilized, Fertilizer⁻ = Not fertilized, CMV⁺ = inoculated with cucumber mosaic virus, OKMV⁺ = inoculated with okra mosaic virus, F⁺ X CMV= Fertilized and inoculated with cucumber mosaic virus interaction, F⁺ X OKMV= Fertilized and inoculated with okra mosaic virus interaction, F⁻ X CMV= Not fertilized and inoculated with cucumber mosaic virus interaction, F⁻ X OKMV= Not fertilized and inoculated with okra mosaic virus interaction, F⁺ fertilized buffer inoculater, F⁻ Not fertilized buffer inoculated, S.E = Standard error.

Table 2: Effect of Fertilizer application and Virus inoculation on plant height

WEEKS AFTER INOCULATION

TREATMENTS	WEEKS AFTER INOCULATION						
	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9
Fertilizer							
Fertilizer ⁺	33.1	49.3 ^a	62.4 ^a	68.5 ^a	76.0 ^a	81.6 ^a	88.2 ^a
Fertilizer ⁻	30.0	33.5 ^b	40.0 ^b	43.0 ^b	47.0 ^b	51.2 ^b	56.6 ^b
ns							
S.E	1.498	2.679	2.836	2.547	1.904	1.939	1.537
Inoculum							
CMV ⁺	30.9	37.9	47.1	54.6	59.6 ^b	63.6 ^b	64.3 ^b
OKMV ⁺	30.0	39.5	45.3	52.6	57.8 ^b	60.7 ^b	64.1 ^b
Control (Buffer)	33.8	46.8	55.1	59.9	67.0 ^a	75.0 ^a	88.7 ^a
ns							
S.E	1.834	3.281	3.473	3.119	2.332	2.375	1.882
Fert. X Inoc.							
F ⁺ X CMV	33.5	35.2 ^d	40.4 ^d	47.8 ^d	55.3 ^{cd}	58.6 ^{cd}	63.9 ^d
F ⁺ X OKMV	31.1	38.2 ^c	44.9 ^c	52.9 ^c	58.9 ^c	66.7 ^c	75.1 ^c
F ⁻ X CMV	28.2	30.1 ^e	35.4 ^e	41.4 ^e	47.1 ^e	51.2 ^e	56.0 ^f
F ⁻ X OKMV	28.8	31.2 ^e	36.7 ^d	43.6 ^e	52.1 ^d	56.1 ^d	60.2 ^{de}
F ⁺ Control	34.8	55.4 ^a	64.2 ^a	72.3 ^a	83.1 ^a	91.3 ^a	106.1 ^a
F ⁻ Control	32.9	46.9 ^b	53.9 ^b	59.4 ^b	70.4 ^b	78.5 ^b	80.4 ^b
ns							
S.E	2.594	4.640	4.912	4.411	3.299	3.359	2.662

Means within a column followed by the same letter(s) are not significantly different using the New Duncan multiple Range Test at P > 0.05

Table 3: Effect of Fertilizer application and Virus inoculation on mean number of leaves

WEEKS AFTER INOCULATION

TREATMENTS	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9
Fertilizer App.							
Fertilizer ⁺	14.5	23.1 ^a	28.5 ^a	31.7 ^a	32.5 ^a	35.3 ^a	38.3 ^a
Fertilizer ⁻	14.3	15.1 ^b	17.1 ^b	16.1 ^b	17.4 ^b	18.5 ^b	23.0 ^b
ns							
S.E	0.420	0.655	0.728	1.046	1.156	0.853	0.459
Inoculum							
CMV ⁺	18.7	17.2 ^b	21.3 ^b	20.5 ^b	21.0 ^b	21.7 ^c	26.3 ^b
OKMV ⁺	18.5	17.8 ^b	21.2 ^b	22.8 ^b	24.3 ^b	25.3 ^b	27.7 ^b
Control (Buffer)	18.0	22.3 ^a	26.0 ^a	28.3 ^a	29.7 ^a	33.7 ^a	38.0 ^a
ns							
S.E	0.515	0.802	0.891	1.282	1.416	1.045	0.563

Fert. X Inoc.							
F ⁺ X CMV	23.3 ^a	20.3 ^{bc}	25.7 ^b	26.7 ^b	27.3 ^b	29.7 ^b	35.0 ^b
F ⁺ X OKMV	22.0 ^a	21.3 ^b	25.3 ^b	28.7 ^b	29.7 ^b	32.7 ^b	34.0 ^b
F ⁻ X CMV	14.0 ^b	14.0 ^b	17.0 ^c	14.3 ^c	14.7 ^c	13.7 ^d	17.7 ^c
F ⁻ X OKMV	15.0 ^b	14.3 ^d	17.0 ^c	17.0 ^c	19.0 ^c	18.0 ^d	21.3 ^d
F ⁺ Control	22.0 ^a	27.7 ^a	34.7 ^a	39.7 ^a	40.7 ^a	43.7 ^a	46.0 ^a
F ⁻ Control	14.0 ^b	17.0 ^{cd}	17.3 ^c	17.0 ^c	18.7 ^c	23.7 ^c	30.0 ^c
S.E	0.728	1.134	1.261	1.813	2.003	1.478	0.796

Means within a column followed by the same letter(s) are not significantly different using the New Duncan multiple Range Test at P > 0.05

Table 4: Effect of Fertilizer application and Virus inoculation on stem girth

TREATMENTS	WEEKS AFTER INOCULATION						
	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9
Fertilizer App.							
Fertilizer ⁺	1.0	1.0 ^a	1.3 ^a	1.4 ^a	1.6 ^a	1.6 ^a	1.9 ^a
Fertilizer ⁻	0.8	0.8 ^b	0.9 ^b	1.0 ^b	1.1 ^b	1.2 ^b	1.3 ^b
S.E	0.065	0.048	0.047	0.034	0.042	0.048	0.029
Inoculum							
CMV ⁺	0.7 ^c	0.7 ^a	1.1	1.1 ^b	1.2 ^b	1.3 ^b	1.4 ^b
OKMV ⁺	0.9 ^b	0.9 ^a	1.1	1.3 ^a	1.3 ^{ab}	1.3 ^b	1.5 ^a
Control (Buffer)	1.1 ^a	1.1 ^a	1.2	1.3 ^a	1.4 ^a	1.6 ^a	1.9 ^a
S.E	0.079	0.058	0.057	0.042	0.051	0.059	0.035
Fert. X Inoc.							
F ⁺ X CMV	0.8 ^b	0.9 ^b	1.3 ^a	1.4 ^{ab}	1.5 ^b	1.5 ^b	1.7 ^b
F ⁺ X OKMV	0.9 ^{ab}	0.9 ^b	1.3 ^a	1.3 ^b	1.5 ^b	1.5 ^b	1.7 ^b
F ⁻ X CMV	0.6 ^b	1.0 ^{ab}	0.9 ^b	0.9 ^d	1.2 ^c	1.2 ^{cd}	1.3 ^c
F ⁻ X OKMV	0.8 ^b	0.6 ^c	0.9 ^b	1.1 ^c	1.0 ^c	1.1 ^d	1.1 ^d
F ⁺ Control	1.2 ^a	1.2 ^a	1.4 ^a	1.6 ^a	1.8 ^a	1.9 ^a	2.2 ^a
F ⁻ Control	0.9 ^b	1.0 ^{ab}	1.3 ^a	1.4 ^{ab}	1.5 ^b	1.6 ^{ab}	1.7 ^b
S.E	0.112	0.082	0.081	0.059	0.072	0.083	0.05

Means within a column followed by the same letter(s) are not significantly different using the New Duncan multiple Range Test at P > 0.05

Table 5: Effect of Fertilizer application and Virus inoculation on fresh shoot weight

Page 2793	TREATMENTS	Fresh shoot weight at harvest (g) / plant
	<u>Fertilizer App.</u>	
	Fertilizer +	2.8 ^a
	Fertilizer -	1.8 ^b
	S.E	0.19
	<u>Inoculum</u>	
	CMV +	1.5 ^b
	OKMV +	1.4 ^b
	Control (Buffer)	2.4 ^a
	S.E	1.68
	<u>Fert. X Inoc.</u>	
	F ⁺ X CMV	1.5 ^c
	F ⁺ X OKMV	1.6 ^c
	F ⁻ X CMV	1.1 ^d
	F ⁻ X OKMV	1.2 ^d
	F ⁺ Control	2.7 ^a
	F ⁻ Control	1.9 ^b
	S.E	0.46

Means within a column followed by the same letter(s) are not significantly different using the New Duncan multiple Range Test at P > 0.05