Performance of selected phytochemicals and botanical nutrient on physiological features of okra varieties against *Yellow vein clearing mosaic virus*

Abstract

A two factorial field experiment on okra was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during April to August, 2017. The aim of the study was to find out the physiological responses of okra varieties against *Yellow vein clearing mosaic virus* (*YVCMV*) under a management progam to control the disease. Four okra varieties viz. BARI dherosh-1, Green finger, Orca onamika and Nuffield were selected as first factor and two phytochemicals (Imidacloprid and Sobicron) and one botanical nutrient namely Peak performance nutrients (PPN) were used as second factor. The plants were grown and natural inoculum was relied upon the infection of YVCMV. Physiological features of okra plants were significantly affected by Yellow vein clearing mosaic virus (YVCMV). So that normal physiological activities of okra varieties were hampered due the attack of the virus. The highest net chlorophyll content, net assimilation rate, intercellular carbon-di-oxide concentration, stomatal conductivity and respiration rate were recorded in Green finger and the lowest in Orca onamika. Sobicron with PPN also gave the highest net chlorophyll content, net assimilation rate, intercellular carbon-di-oxide concentration, stomatal conductivity and respiration rate and the lowest were recorded when no phytochemicals and PPN combination was used. Green finger with the application of Sobicron with PPN showed the best performance of these physiological responses compared to other okra varieties and phytochemicals combinations.

Keywords: Okra, *Yellow vein clearing mosaic virus,* phytochemicals, Peak performance nutrients, physiological features.

1. Introduction

Okra (***Abelmoschus esculentus* L.**) is an important vegetable crop belonging to the Malvaceae family. It is used for food as a vegetable and industrially as a fibre. It is also the good sources of gum, starch, spice and medicinal (eg. diabetese and cancer) products. The green fruits of okra are rich sources of carbohydrate, proteins, vitamins, calcium, potassium and other minerals. The edible portion of pod (100 gm) has moderate levels of vitamin A (0.01 mg) and vitamin C (18 gm), calcium (90mg), phosphorus and potassium. The contents of thiamine (0.07 mg), riboflavin (0.08 mg) and niacin (0.08 mg) per 100 gm edible portion of pod are higher than many others vegetables. Okra is said to be very useful against genito-urinary disorders, spermatorrhoea and chronic dysentery. Its medicinal value has also been reported in curing ulcers and relief from hemorrhoids.

Yellow vein clearing mosaic virus (*YVCMV*) is a member of Geminivirus group which is semi-persistently transmitted by whitefly (*Bemesia tabaci*) [1,3]. The virus is also transmitted through grafting, but not mechanically or through seeds [2,17]. Okra *YVCMV* has been considered as the most important factor of yield reduction in Bangladesh and some other okra growing regions of the sub-continent [4,5]. It is one of the most destructive diseases of okra plants. In the current study, effect of okra *YVCMV* was assessed on plant growth and yield in naturally infected crop [7,8,9]. The virus showed the significant reduction in plant height, number of leaves, flowers, fruits and over all pickings and yield [19,20]. The significant reduction in plant height,flowers formation per plant, fruit weight in infected plants were recorded as compared to healthy plants [6]. Interestingly, on overall basis there were more numbers of leaves in infected plants as compared to healthy one [11,12]. The growth and development of okra plants depend on its normal physiological process. The pathogen may change the normal physiological processes of the infected plants [10,13]. There are some reports on biochemical changes and metabolic activities of okra plants are significantly affected due to the virus infection [14,18]. Information regarding the virus infection causing tremendous yield losses of okra are available [15,16]. But the study on physiological changes due to the virus in infected okra is scanty.

The prime objectives of the experiment were to determine the changes on physiological features and cellular components due to infection of *YVCMV* in okra and to evaluate the performance of phytochemicals and PPN on physiological features and cellular components of okra.

2. Materials and methods

2.1 Materials used in the experiment

Four okra varieties namely BARI dherosh-1, Green finger, Nuffield and Orca onamika were used in the experiment. BARI dherosh-1 was collected from Bangladesh Agricultural Research Institute (BARI), Joydevpur, Gazipur and other three varieties were collected from the local market. The selected phytochemicals namely Imidacloprid and Sobicron were collected from the local market and PPN was collected from China through representative country dealers.

2.2 Design and layout of the experiment

The experiment was laid out in a randomized complete block design (RCBD) with three replications where blocks were representing the replication. Each block comprised 18 unit plot and a total number of plots were 72 (18 X 4=72). Size of each unit plot was 5 m^2. The distance between plot to plot was 0.70 m and block to block was 1 m.

2.3 Intercultural operations and fertilizer application

Preparation of land was done as per treatment. After the establishment of seedlings, various intercultural operations were accomplished for better growth and development of the okra. Proper intercultural operation facilities e.g. thinning and gap filling, weeding and mulching, irrigation and drainage were provided at the right time. Cow dung, TSP, MP, and Urea were applied at the rate of 14 ton/ha, 150 kg/ha, 150 kg/ha and 150 kg/ha respectively. The entire amount of cow dung, TSP, and MP @ 100 kg/ha were applied at the time of final land preparation. The remaining TSP and MP were applied after 30 days of sowing seed. Urea was applied in three equal installments at 30, 45 and 60 days after sowing (DAS).

2.4 Obsevation

The virus produces typical vein yellowing and thickening of leaves forming a network of veins and veinlets in the infected leaves. Initially, the leaves exhibit only yellow colored veins but under the severe infection, the leaves become completely chlorotic and turn yellow. There is reduction of leaf chlorophyll and the infected plants give a stunted look and produce small sized pale yellow fruits. If plants are infected within 20 days after germination, their growth is retarded; few leaves and fruits are formed and loss may be about 90% . The extent of damage declines with delay in infection of the plants. The average chlorophyll content in the leaves of the selected plants was recorded with the help of “S-pad” meter, which is an advanced technology to direct measure of the chlorophyll content in plant leaf at 40, 60 and 80 days after sowing (DAS). In each reading of single leaf was recorded by the machine for three times at three location of the same leaf then the machine automatically gave the average data and value. But the average net assimilation rate, intercellular carbon-di-oxide concentration, respiration rate and stomatal conductivity per plant were recorded from the selected plants by using “LC-Pro+” machine at 40, 60 and 80 days after sowing (DAS).

2.5 Data collection and Statistical analysis

A number of plants and number of infected plants from each plot at 40, 60 and 80 days after sowing (DAS) were recorded. The data were analyzed statistically by using the analysis of variance (ANOVA) and MSTAT-C software for proper interpretation. The mean value was compared according to Duncan's Multiple Range Test (DMRT) at 1% level of significance. Correlation and regression study was also done to check the relationship among the varieties, insecticides, physiological features and yield. Tables and bar graph were used to interpret the data when required.

3. Results

3.1 Effect of varieties on Net chlorophyll content (μ mol m^{-2} s^{-1}), Net assimilation rate (g m^{-2} d^{-1}) and Intercellular carbon-di-oxide concentration (ppm)

The highest observation of net chlorophyll content, net assimilation rate and also intercellular carbon-di-oxide were observed for per plant in Green finger (50.39 a, 1.650 a and 5.833 a) which were just more than BARI dherosh-1 (48.24 b, 1.463 b and 4.833 b). The lowest observations of these physiological features were recorded in Orca onamika (39.11 d, 1.140 d and 4.000 c) which were just less than Nuffield (46.15 c, 1.240 c and 4.500 bc). These results are presented in Table 1.

Table 1: Effect of varieties on Net chlorophyll content (μ mol m-2 s-1), Net assimilation rate (g m-2 d-1) and Intercellular Carbon-di-oxide concentration (ppm)

Variety	Net chlorophyll content (μ mol m^{-2} s^{-1})	Net assimilation rate (g m^{-2} d^{-1})	Intercellular Carbon-di-oxide concentration (ppm)
BARI Dherosh-1	48.24 b	1.463 b	4.833 b
Green finger	50.39 a	1.650 a	5.833 a
Orca onamika	39.11 d	1.140 d	4.000 c
Nuffield	46.15 c	1.240 c	4.500 bc
$LSD_{0.01}$	0.6521	0.02832	0.7689
CV%	1.58	1.78	17.92

3.2 Effect of varieties on Stomatal conductivity (mol m^{-2} s^{-1}) and Respiration rate (ppt/s)

The highest stomatal conductivity and respiration rate were found in Green finger (0.2333 a and 40.82 a) which were more than BARI dherosh-1 (0.2206 a and 36.57 b). The lowest stomatal conductivity and respiration rate were found in Orca onamika (0.1867 b and 33.98 d) which were less than Nuffield (0.2083 ab and 35.77 c). The results are presented in Table 2.

Table 2:Effect of varieties on Stomatal conductivity (mol m-2 s-1) and Respiration rate (ppt/s)

Variety	Stomatal conductivity (mol m^{-2} s^{-1})	Respiration rate (ppt/s)
BARI Dherosh-1	0.2206 a	36.57 b
Green finger	0.2333 a	40.82 a
Orca onamika	0.1867 b	33.98 d
Nuffield	0.2083 ab	35.77 c

LSD $_{0.01}$	0.02832	0.2157
CV%	11.29	0.66

3.3 Effect of phytochemicals and PPN on Net chlorophyll content (μ mol m^{-2} s^{-1}), Net assimilation rate (g m^{-2} d^{-1}) and Intercellular Carbon-di-oxide concentration (ppm)

Application of Sobicron with PPN (48.56 a, 1.405 a and 7.250 a) provided the highest net chlorophyll content, net assimilation rate and also intercellular carbon-di-oxide respectively. Moderate performance was observed when any one of Imidacloprid with PPN (48.06 a, 1.385 ab and 5.500 b), Imidacloprid (45.70 bc, 1.378 ab and 4.000 cd), Sobicron (46.44 b, 1.375 ab and 4.000 cd) and PPN (45.06 c, 1.360 bc and 4.750 bc) were applied. When application with no insecticides and PPN (42.03 d, 1.337 c and 3.250 d) were applied gave the lowest performance of these physiological responses. These results are presented in Table 3.

Table 3: Effect of phytochemicals and PPN on Net chlorophyll content (μ mol m-2 s-1), Net assimilation rate (g m-2 d-1) and Intercellular Carbon-di-oxide concentration (ppm)

Phytochemicals and PPN	Net chlorophyll content (μ mol m^{-2} s^{-1})	Net assimilation rate (g m^{-2} d^{-1})	Intercellular Carbon-di-oxide concentration (ppm)
Control	42.03 d	1.337 c	3.250 d
PPN	45.06 c	1.360 bc	4.750 bc
Imidacloprid + PPN	48.06 a	1.385 ab	5.500 b
Sobicron + PPN	48.56 a	1.405 a	7.250 a
Imidacloprid	45.70 bc	1.378 ab	4.000 cd
Sobicron	46.44 b	1.375 ab	4.000 cd
LSD $_{0.01}$	0.7986	0.03469	0.9417
CV%	1.58	1.78	17.92

3.4 Effect of phytochemicals and PPN on Stomatal conductivity (mol m^{-2} s^{-1}) and Respiration rate (ppt/s)

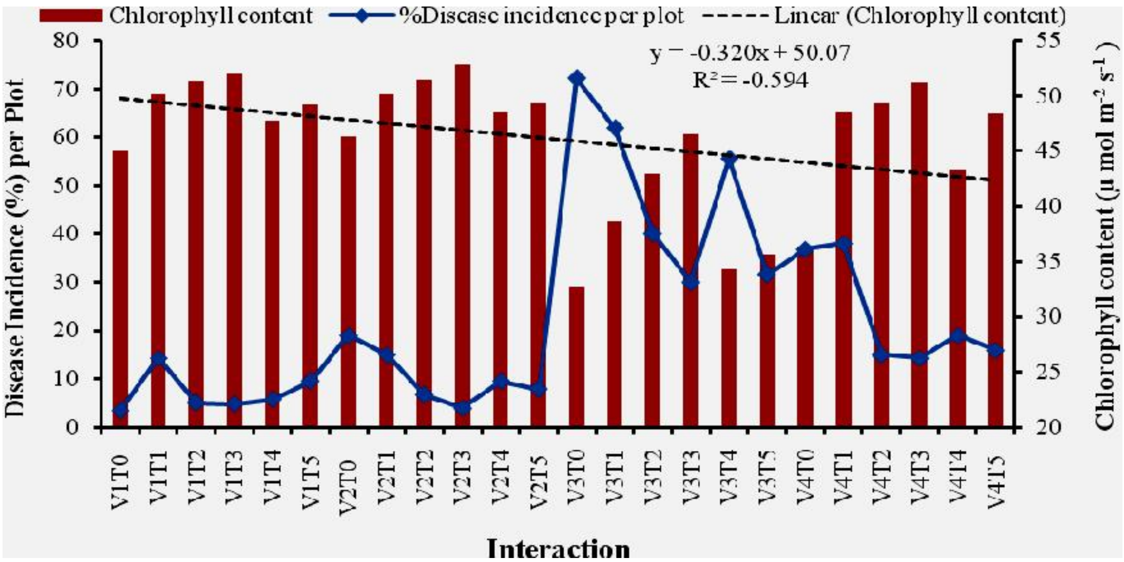
The highest observations of stomatal conductivity and respiration rate were found when Sobicron with PPN (0.2458 a and 39.78 a) was applied. Moderate performance were found when any one of Imidacloprid with PPN (0.2183 bc and 37.28 b), Imidacloprid (0.2142 abc and 36.97 c), Sobicron (0.2125 abc and 36.35 d) and PPN (0.2050 ab and 37.28 b) were applied. The lowest stomatal conductivity and respiration rate were found with the application of no insecticides and PPN (0.1775 c and 33.05 e). The results are presented in Table 4.

Table 4: Effect of phytochemicals and PPN on Stomatal conductivity (mol m^{-2} s^{-1}) and Respiration rate (ppt/s)

Phytochemicals and PPN	Stomatal conductivity (mol m-2 s-1)	Respiration rate (ppt/s)
Control	0.1775 c	33.05 e
PPN	0.2050 ab	37.28 b
Imidacloprid + PPN	0.2183 bc	37.28 b
Sobicron + PPN	0.2458 a	39.78 a
Imidacloprid	0.2142 abc	36.97 c
Sobicron	0.2125 abc	36.35 d
LSD 0.01	0.03469	0.2642
CV%	11.29	0.66

3.5 Correlation coefficient between chlorophyll content (µ mol m^{-2} s^{-1}) and Disease Incidence (%) per Plot

Correlation coefficient study was done to establish the relationship between the chlorophyll content (µ mol m^{-2} s^{-1}) and disease incidence (%) per plot. From the study it was revealed that significant correlation was observed between the parameters (Figure 1). It was evident from the Figure 1, the equation y = -0.320x + 50.07 gave a good fit to the data, and the co-efficient of determination (R^2 = -0.594) showed that, fitted regression line had a significant regression co-efficient. From these relations it can be concluded that the disease incidence (%) per plot was negatively (slope= -0.183) correlated with the chlorophyll content of okra plants.



~~Figure 1:Relationship between Chlorophyll content and Disease incidence (%) per Plot.~~

Figure 1. Relationship between Chlorophyll content and Disease incidence (%) per Plot.

V1= BARI dherosh-1, V2= Green finger, V3= Orca onamika, V4= Nuffield, T0= Control (No phytochemicals and PPN), T1= Peak Performance Nutrients (PPN), T2= Imidacloprid with PPN, T3= Sobicron with PPN, T4= Imidacloprid, T5= Sobicron.

3.6 Correlation coefficient between chlorophyll content (µ mol m^{-2} s^{-1}) and Disease Incidence (%) per Plant

Correlation coefficient study was done to establish the relationship between the chlorophyll content (µ mol m^{-2} s^{-1}) and disease incidence (%) per plant. From the study it was revealed that significant correlation was observed between the parameters (Figure 2). It was evident from the Figure 2, the equation y = -0.592x + 54.51 gave a good fit to the data, and the co-efficient of determination (R^2 = -0.372) showed fitted regression line had a significant regression co-efficient. From these relations it can be concluded that the disease incidence (%) per plant was negatively (slope= -0.115) correlated with the chlorophyll content of okra plants.

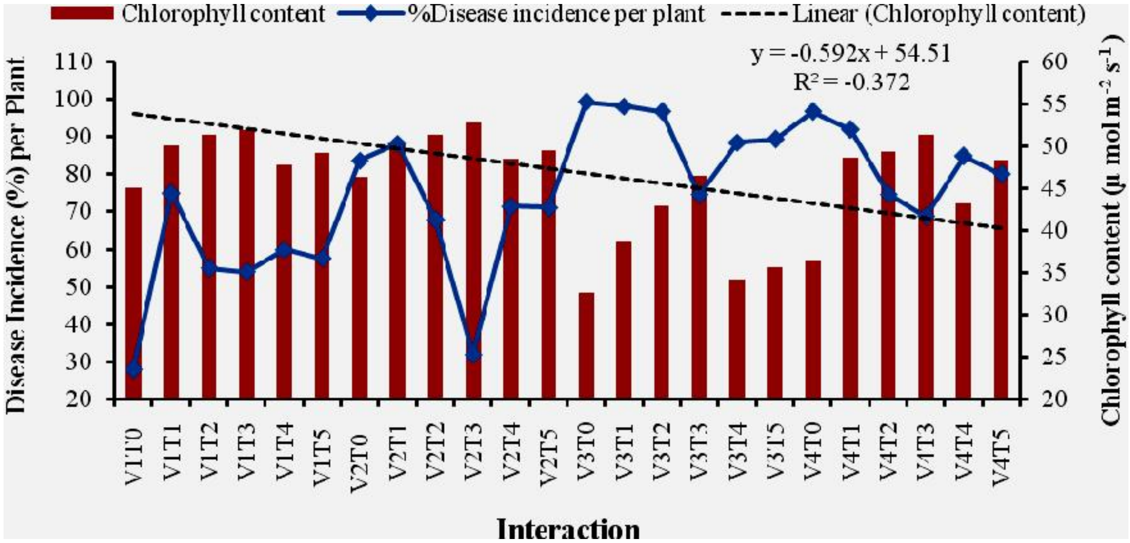


Figure 2. Relationship between Chlorophyll content and Disease incidence (%) per Plant.

V1= BARI dherosh-1, V2= Green finger, V3= Orca onamika, V4= Nuffield, T0= Control (No phytochemicals and PPN), T1= Peak Performance Nutrients (PPN), T2= Imidacloprid with PPN, T3= Sobicron with PPN, T4= Imidacloprid, T5= Sobicron.

3.7 Correlation coefficient between chlorophyll content (µ mol m^{-2} s^{-1}) and Yield (kg)

Correlation coefficient study was done to establish the relationship between the chlorophyll content (µ mol m^{-2} s^{-1}) and Yield (kg) of okra plants. From the study it was revealed that significant correlation was observed between the parameters (Figure 3). It was evident from the Figure 3, the equation y = 0.390x + 5.10 gave a good fit to the data, and the co-efficient of determination (R^2 = 0.62) showed fitted regression line had a significant regression co-efficient. From these relations it can be concluded that the chlorophyll content of okra was positively (slope= 0.367) correlated with the yield of okra plants.

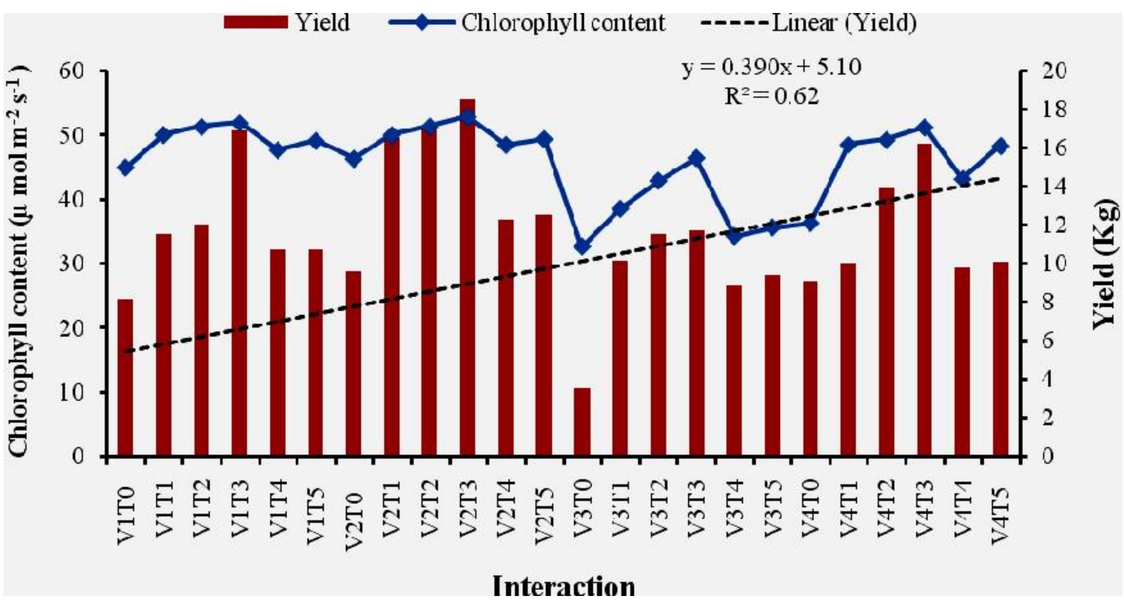


Figure 3: Relationship between Chlorophyll content and Yield

V1= BARI dherosh-1, V2= Green finger, V3= Orca onamika, V4= Nuffield, T0= Control (No phytochemicals and PPN), T1= Peak Performance Nutrients (PPN), T2= Imidacloprid with PPN, T3= Sobicron with PPN, T4= Imidacloprid, T5= Sobicron.

4. Discussion

In case of variety, all of these physiological contents mention as before, Green finger showed the best performance where Orca onamica gave very poor performance. BARI dherosh-1 and Nuffield can be considered as moderate performer response to these physiological features. Among the phytochemicals, Sobicron with PPN combinations performed as better than any other phytochemicals where minimum outcome was come from the application of no phytochemicals with PPN. Green finger with the application of Sobicron with PPN showed the best physiological performance at all growth stages as compared to other varieties and phytochemicals.

Correlation coefficient and linear regression were performed to determine the relationship between chlorophyll content with disease incidence per plot and plant and fruit yield. From the correlation study, it was revealed that the disease incidence per plot as well as plant was negatively correlated with the chlorophyll content and the chlorophyll content was positively correlated with the fruit yield. Chlorophyll contents were increased with the decreases of disease incidence. Yield of okra was increased with the increases of chlorophyll contents. Orca onamika application with no phytochemicals and PPN showed the highest disease incidence per plot and plant with the lowest chlorophyll content and lowest fruit yield.

5. Conclusion

Yield and yield contributing characters and physiological features of okra plants are changed due to the infection of ~~*Yellow vein clearing mosaic virus (YVCMV)*~~ which cause serious damages of okra production and reduce the market value. Development of host resistance to the virus is one of the important strategy against the okra *YVCMV,* which is the most economical and environment friendly process for reducing the yield potential of okra. But due to the sterility problem of *YVCMV*, it is not easy to transfer the resistant gene directly among the cultivated okra varieties. Restoration of fertility through colchicine treatment in the crosses between resistant wild and susceptible species could be a suitable technique. Pathologists and breeders are advised to work more on evaluation of resistant varieties using advanced molecular tools. The growers also should be taken preventive as well as curative control measures to reduce the yield losses.

6. Refferences

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