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RESEARCH ARTICLE

Survey of *Sugarcane Mosaic Virus* disease by using principle components analysis on four ages and its effects on characteristics of two sugarcane varieties on two seasons.

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Abstract

Sugarcane mosaic virus(SCMV) is one among many viruses that infects sugarcane; causes yield loss and becomes serious disease on sugarcane plantations. This research aimed to survey it on commercial sugarcane varieties G.T. 54-9 in 19 locations of Esna district Luxor governorate during 2018/19 on 4 ages and effect of infection with virus on growth, juice quality and yield components of two sugarcane varieties viz., G. T. 54-9 and G. 2017-57 at El-Mattana Research Station, Luxor Governorate during 2018/19 and 2019/20 seasons. Mosaic symptomatic plants were observed in nineteen production areas, with incidences ranging from 0 to 93.33%. The spatial pattern and geographical distribution of disease incidence suggested that infected seed cane was the main source to spread of the disease. Surveyed results revealed that disease incidence was varied between surveyed locations. Plant cane was lower than first and second ratoons in all fields. Locations i.e. El-trakee (Awladhamid) (EN4), Elfarsea (30-115 El-motawlelgrby) (EN7), El-Dkera (Mohamed Hassan) (EN18) and El-Adima (Abd-elrahman) (EN19 were free infection from such disease. The results revealed that a significant reduction in number of millable cane/m^2, stalk diameter (cm.), stalk length (cm.) and number of internodes/plant in G. T. 54-9 and G. 2017-57 varieties due to virus infection. On the other hand, infection of two tested sugarcane varieties with SCMV caused significant reduction in juice extraction (kg)**,** brix (TSS) %, purity%, pol% and sugar recovery%. It significantly increased of sucrose% and reducing sugars% in two tested varieties in two tested seasons also infection with virus caused significant decreased in cane yield (tons/fed.) and sugar yield (tons/fed.)

Keywords: Sugarcane; *Sugarcane mosaic virus*; Survey; Sugarcane qualities

INTRODUCTION

Sugarcane crop (*Saccharum spp*), are important commodities in agriculture that have high economic value and the main ingredient in the production of sugar (Prabowo, *et al.* 2014). Sugarcane cultivated widely in tropical and subtropical regions of the world. Sugarcane is one of the main cash and industrial crops in Egypt. It is a source of raw material to sugar industry and numerous agro-based industries. The area cultivated with sugarcane in 2019/20 for sugarcane production was 323038 feddan yielded about 930255 tons sugar

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represents 37.8% of the sugar productivity (Annual Report for Sugar Crops in Egypt, December, 2019). The production of sugar cane dropped when sugarcane particular infected with diseases or pests in sugarcane plantations(Mehareb*et al*. 2018 and Mehareb and El-Mansoub 2020). Sugarcane affected by various diseases, which figure as one of the main factors contributing to sugarcane yield losses worldwide. Viruses are most important sugarcane diseases causing epidemics and losses in sugarcane production in the world (Gonçalves *et al*. 2012). Virus infected plants either deteriorate quality or reduce the yield to a significant level. SCMV is one of the most widely distributed and important pathogens of sugarcane worldwide causing the disease known simply as mosaic (Thorat *et al.* 2015). The disease was responsible for drastic epidemics in sugarcane in Argentina, Brazil, Cuba, Puerto Rico and USA in the beginning of the 20th century, accounting for the near collapse of the sugarcane industry (Yang and Mirkov 1997). The main virus infecting sugarcane in Egypt is *Sugarcane mosaic virus* SCMV. Mosaic caused by *sugarcane mosaic virus* SCMV belonging to *Potyviridae*,(Mehareb*et al*. 2018; Osman andSalem 2018). On the other hand, it is one of the most potentially dangerous diseases of sugarcane and is widely distributed in sugarcane growing countries (Viswanathan and Balamuralikrishnan 2005). In Egypt was recorded presence two strains infected sugarcane crop i.e. *sugarcane mosaic virus* SCMV and *sugarcane streak mosaic virus*. However, SCMV a major disease to be considered for selection and development of new cultivars in Egypt. Typically, mosaic disease shows yellowing and chlorosis on leaves in the affected sugarcane, resulting in yield loss for both crop yield and sugar production (Yahaya *et al*. 2014). The virus causes yield loss and major problems in most of the sugarcane growing countries and many varieties have gone out of cultivation due to yield losses of up to 50 per cent (Viswanathan and Balamuralikrishnan 2005). Putra *et al.* 2014) reported that sugarcane loss due to mosaic disease is about 20% with 50% of incidence. Similarly, Agnihotri (1996) stated that SCMV causes an appreciable damage in susceptible varieties and even 10-15 % yield loss due to this disease is highly significant because of its extensive cultivation. Most of the sugarcane varieties under cultivation in Upper Egypt and in sugarcane breeding program show symptoms of the disease under natural conditions. The present study was planned to survey and incidence of SCMV disease in 19 locations in Esna district, Luxor governorate in 2018/19 season based on principal components biplot analysis, and its impact on sugarcane growth, juice quality and yield components in two sugarcane varieties i.e. G.T.54-9 and G. 2017- 58.

Materials and Methods

1. Survey of natural infection with SCMV disease:

The SCMV disease on sugarcane crop was surveyed in 19 locations in Esna, distract. Luxor governorate during the 2018/19 growing season to account the occurrence of SCMV disease. Naturally infected sugarcane plantlets exhibiting disease symptoms were surveyed (Thorat*et al.* 2015). SCMV disease surveyed on sugarcane plants cv. G.T. 54-9 as commercial variety grown at 19 different districts belong to Esna district, namely El-namsa (aljazira) (EN1), El-namsa (kharij alzimam) (EN2), El-serab (Abd-elrahem) (EN3), El-trakee (Awladhamid) (EN4), El-trakee (El-ghaba 8) (EN5), Asfon (El-ngel), (EN6), Elfarsea (30-115 El-motawlelgrby) (EN7), El-nwaser (Shabeb) (EN8), El-msawea (El-haraga 2) (EN9), Tfnes (Eslahzeraei 23) (EN10), Tfnes (Eslahthany bahary) (EN11), Hmra Doom (El-Sanosi) (EN12), El-Gwaida (El-Howasha) (EN13), El-Gwaida (El-Awagel) (EN14), El-Karaia (El-Berak) (EN15), El-Karaia (El-Rezga) (EN16), Kommar (El-mehreziabahary) (EN17), El-Dkera (Mohamed Hassan) (EN18) and El-Adima (Abd-elrahman) (EN19). Three fields were chosen randomly in May per each crop ages (plant cane, first, second and third ratoons) in each locations. Diseased plants showing typical symptoms of SCMV were surveyed in the exact locations. Sampling sites were determined with a field map, 5 sampling sites were designated per field tested, one of each of the four corners plus one in the center of the field. Sampling sites were located at 5 m from the edge of the field.

2. Susceptibility of two sugarcane varieties to infection with SCMV disease

The experiment was conducted under field conditions, at two growing seasons of (2018/19 and 2019/20) in the experimental farm of El-Mattana Research Station, Luxor governorate because in this station, the susceptibility of new sugarcane plants were evaluated there. This farm lies in separated area prepared disease experiment (25 ° 41'0"N, 32 ° 39'0"E.). The experimental unit area was 35m^2 (7m in length and 5m width (1/120 feddan). Each treatment contained 3 plots which included 5 rows and 100 cm. between rows and 1m apart between any plot. The susceptible sugarcane varieties i.e. G.T. 54-9 and G.2017-58 to infection with SCMV were used. Infected and healthy seeds materials of two sugarcane varieties were brought from breeding program farm cultivated in El-Mattana Research Station. In the first week of March in two successive seasons, Setts of healthy and diseased of each variety containing three buds were planted. Each row (7 meter in length) was cultivated by 46 double cuttings consisted of three buds of G. T. 54-9 and G.2017-58 varieties. The agronomical practices in sugarcane field were done as usual. The recommended doses of NPK at rates of 230 kg N/feddan, 60 kg P_2O_5 and 48 kg K_2O/ fed., were used.

Data were recorded as following

1. Survey of natural infection with SCMV disease

The average of disease incidences were calculated in 19 locations.

2. Susceptibility of two sugarcane varieties to infection with SCMV disease

At harvest after eleven months from planting, a sample of 10 millable cane stalks was taken at random from each replicate (plot) in healthy and infected plants to determination the infected percentage with SCMV of G.T. 54-9 and G. 2017-54 sugarcane varieties.

Infected stalks percentage with disease calculated:

Infected stalks % =

$$\frac{\text{Number of naturally infected plants}}{\text{Number of total grown plants}} \times 100$$

2.1. Growth parameters of sugarcane plants

Measures of growth of healthy and diseased sugarcane plants were recorded after eleven months from planting.

2.1.1. Growth attributes:-

2.1.1.1. Number of millable cane/m^2.

2.1.1.2. Stalk diameter (cm.) at the middle part of the stalk.

2.1.1.3. Stalk length (cm.) from land level till-dew-lap.

2.1.1.4. Number of internodes/plant.

2.2. Juice Quality

2.2.1.Preparation of samples for juice quality assays

The same samples mentioned previously which evaluated to susceptibility of two sugarcane varieties to infection with SCMV disease were topped, stripped, cleaned then squeezed by an electric pilot mill. The extracted juice was mixed thoroughly and a sample of one liter was poured in a graduated cylinder and left to settle for 15-20 minutes to remove the foams and setting the sediments before starting chemical analysis of the following characters.

2.2.1.1. Juice extraction (kg)

The same samples mentioned above were weighed and followed by juice extraction using three roller power operated Standard, then juice weight (kg) was recorded according to Bagyalakshmi *et al.* (2019).

2.2.1.2. Brix (TSS) percentage

The percent of Total Soluble Solids (TSS) as birx in sugarcane juice was estimated by using brix hydrometer according to the method described by Anonymous (1981).Temperature of the juice was noted. These brix readings were corrected with the help of Schmitz's table (Spancer and Meade. 1963).

2.2.1.3. Sucrose percentage

Sucrose percentage in juice was determined according to the method of Meade and Chen (1977) as following: 50 ml of filter juice and 5 ml of neutral lead acetate 5% as regent were putted into 250 measuring flask then diluted to the mark with distilled water. The solution was filtrated and the supernatant was placed in Saccharimeter (West Germany INSTRNO.139582 Dr. WONFGANG) tube and take the reading. according to A. O. A. C. (1995).

2.2.1.4. Purity percentage:

Purity percentage: it was calculated according to the following formula of Singh and Singh (1998):

$$\text{Purity percentage} = \frac{\text{Sucrose percentage}}{\text{Brix percentage}} \times 100$$

2.2.1.5. Pol percentage

-The Pol percentage was calculated according to the following formula described by Meade and Chen (1977).

-Pol percentage = Sucrose percentage × Pol factor.

-Pol factor = 100-{(fiber percentage × 1.3) + 2.5 percentage}Where. 1.3 = brix free water. 2.5= the trash dedication % cane (sediments % + leaves %).

2.2.1.6. Sugar recovery percentage

Sugar recovery percentage was calculated according to the formula described by Yadav and Sharma (1980): Sugar recovery % =[S - 0.4 (B – S)] × 0.73

Where: B = Brix reading. S = Sucrose percentage.0.4 and 0.73 constants.

2.2.1.7. Reducing sugars percentage

It was determined using Fehling solution according to Lane and Eynonmethod as mentioned in A. O. A. C (1995).

2.3.Yield components

2.3.1. Cane yield (tons/fed.)

It was determined from the guarded rows of each plot at harvest and topped, cleaned and weighted. The cane yield (tons/feddan) was calculated.

2.3.2. Sugar yield (t/fed.)

It was calculated according to the following formula described by Yadav and Sharma (1980.

Sugar yield (t/fed.) = net cane yield (t/fed.) × sugar recovery percentage.

Statistical analysis

Data of the experiments were transferred into angular transformation and subjected for ANOVA to calculate the (L.S.D) at 5% probability for testing the significance of the differences among the mean values of the tested treatments. Split plot with three replications was used in both seasons as mentioned by (Gommez and Gommez. 1984) of "MSTAT-C" computer software program that was applied according to (Freed *et al.* 1989). The additive main effect and multiplicative interaction (AMMI) analysis of the four ages of crop (plant cane, first, second and third ratoon) were carried out in 19 locations. AMMI Biplot for analysis of interaction of locations × crop ages, the AMMI model equation according to Gauch, and Zobel, (1996).

RESULTS and DISCUSSION

SCMV definite member of family Potyviridae (Shukla and Ward 1994), which is known to infect sugarcane (Rao *et al.* 2003). Symptoms of SCMV disease on commercial sugarcane variety G.T. 54-9 in Egypt were chlorotic streaks, severe mosaic and reddish necrotic streaks Fig. (1).


Fig. 1. : Naturally infection in leaves of sugarcane variety G.T.54-9 with SCMV(Right) and healthy leaves (Left).

1. Survey of natural infection with SCMV disease:

The obtained results in Table (1) indicate that natural infected with SCMV disease was significantly affected by locations. Data proved that SCMV disease was observed in all surveyed locations during 2018/19 growing season with different degrees of susceptibility. The highest values of infection percentage (93.33%) was obtained in EN9 and EN11 location in third ratoon of commercial sugarcane cultivar G.T.54-9, followed by EN 16 (90.00%). The lowest values(0.00%) of infection with SCMV was recorded in EN1, EN2, EN3, EN4, EN5, EN7, EN8, EN9, EN13, EN15, EN18 and EN19 districts in plant cane. On the other hand, it was recorded in EN1, EN4, EN7, EN9, EN12, EN14, EN18 and EN19 districts in the first ratoon). The lowest infection percentage was recorded in EN4, EN7, EN12, EN14, EN18 and EN19 districts in the second ratoon) and it was recorded in EN4, EN7, EN18 and EN19 districts in the third ratoon).

Generally, the EN4, EN18 and EN19 were free of infection with that disease, however, the EN6, EN10, EN11, EN16 and EN17.

2. Susceptibility of two sugarcane varieties to infection with SCMV disease

Reaction of two sugarcane varieties i.e. (G.T.54-9 and G. 2017-58) to infection with the SCMV disease, was tested under field conditions and used healthy and infected plants Fig. (2) of two sugarcane varieties in the successive seasons 2018/19 and 2019/20. Results indicate that the two tested sugarcane varieties were susceptible to infection with SCMV and their infection percentages were 100% for both varieties in two tested seasons. Singh *et al.* (1997)

Table1. Mosaic incidence of G.T. 54-9 in Esna, distract, Luxor Governorate during 2018/19 season for 4 different crop ages.

Locations	Crop ages				
	Plant cane	1st ratoon	2nd ratoon	3rd ratoon	Mean
EN1	0.00	0.00	23.33	53.33	19.17
EN2	0.00	40.00	59.07	86.11	46.30
EN3	0.00	20.00	26.67	30.00	19.17
EN4	0.00	0.00	0.00	0.00	0.00
EN5	0.00	3.33	33.33	80.00	29.17
EN6	77.59	76.11	80.00	83.33	79.26
EN7	0.00	0.00	0.00	0.00	0.00
EN8	0.00	26.67	53.33	80.00	40.00
EN9	0.00	0.00	3.33	93.33	24.17
EN10	2.22	38.89	44.44	45.83	32.85
EN11	8.52	10.00	86.67	93.33	49.63
EN12	1.59	0.00	0.00	14.29	3.97
EN13	0.00	10.67	16.67	20.00	11.83
EN14	1.11	0.00	0.00	3.33	1.11
EN15	0.00	46.67	50.00	53.33	37.50
EN16	8.52	83.33	86.67	90.00	67.13
EN17	2.96	10.00	13.33	13.33	9.91
EN18	0.00	0.00	0.00	0.00	0.00
EN19	0.00	0.00	0.00	0.00	0.00
Mean of crop ages	5.40	19.25	30.36	44.19	24.80
$L.S.D_{0.05}$					
Locations (A)					8.22
Crop ages (B)					3.07
Interaction (A×B)					13.38

found that SCMV disease cause major problems in most of the sugarcane growing countries and many varieties. Bagyalakshmi *et al.* (2019) revealed that growth, yield and juice quality parameters were significantly reduced in infected plants of sugarcane when compared to the healthy ones due to infection with SCMV.

AMMI Biplot analysis:

The combined analysis of difference and AMMI analysis was exposed in (Figures 2). It was observed that there were highly significant differences for the environment, ages and their interactions. Environments EN4, EN7, EN18 and EN19 were the biggest contributor to the phenotypic stability of these ages (Fig. 3). No variances ($p > 0.05$) were found among ages via the individual ANOVA. Moreover, these environments recorded of the lowest ages means. On the other hand, environment E9 mostly contributed to the infection on third ratoon.

G.2017-58 variety: Healthy sample(Left) and infected sample(Right)

G.T.54-9 variety: Healthy sample(Left)and infected sample (Right)

Fig. 2. Effect of infection with SCMV on growth and length (cm.) of G.2017-58 and G.T.54-9 varieties.

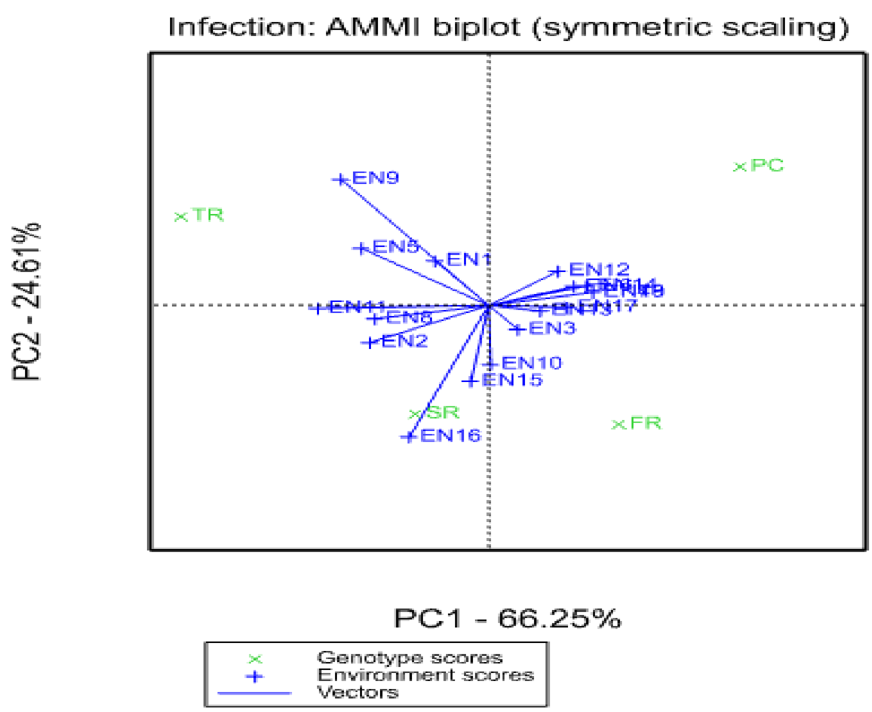


Fig. 3. AMMI1 Biplot with the first principal axis of interaction (PCI1) x four ages (plant cane, first, second and third ratoon) of sugarcane ages in 19 environments

2.1. Effect of SCMV disease on growth of sugarcane plants:

Effect of infection with SCMV disease on growth parameters of two sugarcane varieties and positively and negatively changes in growth parameters were recorded (Fig. 4) under field conditions in the successive seasons 2018/19 and 2019/20.

2.1.1. Number of millable cane/m^2:

Data in Table (2) showed that mosaic disease significantly decreased number of millable cane/m^2 of the tested sugarcane varieties in the two test seasons. It could be noticed that, the highest number of millable cane/m^2 (11.00 and 10.84 stalks/m^2) was obtained by G. 2017- 58 variety in the first and second seasons, respectively. However, the lowest number of millable cane/m^2 (9.33 and 10.00 stalks/m^2) was recorded in G.T. 54-9 in the first and second season, respectively. Concerning the effect of infection with SCMV pathogen on number of millable cane/m^2 under pathogen stress, it was observed decreasing in infected plants in both tested seasons compared with non- infected sugarcane plants. The highest number of millable cane/m^2 (11.33 and 11.67 stalks/m^2) was recorded in two sugarcane varieties non-infected with SCMV in the first and second seasons, respectively. On the other hand, the lowest number of millable cane/m^2 (9.00 and 9.17stalks/ m^2) was recorded in infected sugarcane varieties in the first and second seasons, respectively. These results agreement with Viswanathan and Balamuralikrishnan (2005),who found that, significant reduction in number of millable canes due to infected with SCMV in sugarcane varieties at the time of harvest.

Table 2. Effect of SCMV disease on number of millable cane/m^2 of two sugarcane varieties in 2018/19 and 2019/20 growing seasons, under field conditions.

Seasons			2018/19		
Varieties	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	10.33	8.33	9.33	2.00	19.36
G.2017-58	12.33	9.67	11.00	2.66	21.57
Mean	11.33	9.00	10.17	2.33	20.56
			2019/20		
	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	11.33	8.67	10.00	2.66	23.48
G.2017-58	12.00	9.67	10.84	2.33	19.42
Mean	11.67	9.17	10.42	2.50	21.42
L.S.D. at 0.05					
	2018/19	2019/20			
Varieties (A)	0.38	0.38			
Infected (B)	0.93	0.65			
Interaction (A×B)	NS	NS			

Interaction between tested sugarcane varieties and infection with SCMV was insignificant effect on number of millable cane/m^2 in both tested seasons.

2.1.2. Stalk diameter (cm.):

Data in Table (3) clearly demonstrate that the infection of sugarcane plants with SCMV significantly decreased in stalk cane diameter in tested sugarcane varieties in the two growing seasons. The greatest stalk diameter was recorded in G.T. 54-9 variety (2.25cm) in the first season, and (2.46cm) in the second season. Reduction in stalk diameter of the same variety amounted by 0.44 and 0.55cm in two tested seasons, respectively, and percentage of reduction in stalk diameter amounted 17.81 and 20.15% in both tested seasons, respectively. On the other hand, the least stalk diameter was recorded in G. 2017-58 variety (1.75 and 1.77 cm) in the first and second seasons, respectively. At compared to healthy and diseased plants of G. 2017- 58 variety, reduction in stalk diameter amounted by 1.31 and 1.01cm in two tested seasons, respectively, and percentage of reduction in stalk diameter amounted 54.58 and 44.49%, in both tested seasons respectively. Such results are in agreement with those reported by Viswanathan and Balamuralikrishnan (2005), who found that cane stalks taken from virus-infected plots at harvest recorded a significant reduction in cane diameter. Bagyalakshmi*et al.*, (2019) indicated that growth parameters were significantly reduced in infected plants of sugarcane when compared to the healthy ones due to infection with SCMV.

Under infection of two sugarcane varieties with SCMV disease, the stalk diameter of cane was lower in plants infected with SCMV than healthy in first and second seasons, the stalk diameter of sugarcane markedly decreased by 0.88 and 0.78cm in the first and second seasons, respectively. Percentage of reduction reached 36.07 and 31.20% in both tested seasons, respectively. Concerning the interaction between sugarcane varieties and infection with SCMV, the highest stalk diameter (2.47and 2.73cm) was recorded in G. T.54-9 variety in the first and second seasons, respectively, while the lowest stalk diameter (1.09and 1.26 cm) was recorded in G. 2017- 58 in the first and second seasons, respectively. Results showed that infection of sugarcane plants with SCMV significant decrease in stalk cane diameter in the two growing seasons.

2.1.3. Stalk length (cm.):

Data presented in table (4) illustrated that the stalk length of sugarcane plants significantly reduced by infection with SCMV pathogen in the tested sugarcane varieties. The greatest reduction of stalk length (213.34 and 204.53cm.) was recorded in G. 2017- 58 variety in the first and second seasons, respectively. At the same time the least reduction of stalk recorded in G.T. 54-9 variety in first and second seasons, respectively. Such results are in accordance

Table 3. Effect of SCMV disease on stalk diameter (cm.) of two sugarcane varieties in 2018/19 and 2019/20 growing seasons. under field conditions.

Seasons	2018/19				
Varieties	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	2.47	2.03	2.25	0.44	17.81
G.2017-58	2.40	1.09	1.75	1.31	54.58
Mean	2.44	1.56	2.00	0.88	36.07
			2019/20		
	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	2.73	2.18	2.46	0.55	20.15
G.2017-58	2.27	1.26	1.77	1.01	44.49
Mean	2.50	1.72	2.11	0.78	31.20
L.S.D. at 0.05					
	2018/19	2019/20			
Varieties (A)	0.16	0.12			
Infected (B)	0.20	0.20			
Interaction (A×B)	0.29	0.27			

with Viswanathan and Balamuralikrishnan (2005), who stated that infected sugarcane plants with SCMV disease effect significantly on growth parameters. Significant differences were observed in effect of SCMV on stalk length in both seasons. Mean of stalk length of sugarcane plants was higher in healthy plants (280.97and 271.42 cm.) than in plants infected with SCMV (154.61 and 151.65cm.) in the first and second seasons, respectively. Concerning to the interaction between infection with SCMV pathogen and sugarcane varieties on stalk length,

Table 4. Effect of SCMV disease on stalk length (cm.)of two sugarcane varieties in 2018/19 and 2019/20 growing seasons. under field conditions.

Seasons	2018/19				
Varieties	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	302.50	142.00	222.25	160.50	53.06
G.2017-58	259.45	167.22	213.34	92.23	35.55
Mean	280.97	154.61	217.79	126.36	44.97
			2019/20		
	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	299.33	137.75	218.54	161.58	53.98
G.2017-58	243.50	165.56	204.53	77.94	32.01
Mean	271.42	151.65	211.54	119.77	44.13
L.S.D. at 0.05					
	2018/19	2019/20			
Varieties (A)	10.18	5.52			
Infected (B)	11.61	5.58			
Interaction (A×B)	16.42	7.89			

the highest stalk length (302.50 and 299.33cm) was recorded in healthy of G.T. 54-9 variety in first and second seasons, respectively. On the other hand, the lowest cane length (142.00 and 137.75) was recorded in infected of G.T. 54-9 variety in the first and second season, respectively.

2.1.4. Number of internodes/plant:

Table (5) confirmed that a significant reduction was observed in number of internodes/plant of two tested sugarcane varieties after infection with SCMV pathogen. The highest number of internodes/plant (19.00 and 18.38 internodes/plant) was found in G.T. 54-9variety in the first and second seasons, respectively. Moreover, the lowest number of internodes/plant (13.56 and 15.45 internodes/plant) was found in G. 2017-58varietyin the first and second seasons, respectively. Such results are in agreement with those reported by Viswanathan and Balamuralikrishnan, 2005 and Gonçalves *et al.*2012, who found that at harvest, cane stalks taken from virus-infected plots recorded a significant reduction in number of internodes/plant.

Compared with control plants, in the first and second season, the infection with SCMV pathogen significantly decreased number of internodes/plant in each sugarcane variety. Concerning to the interaction between infection with SCMV pathogen and sugarcane varieties on number of internodes/plant, G.T. 54-9 sugarcane variety had the highest number of internodes/plant (21.20 and 22.45 internodes/plant) in the first and second seasons, respectively. On the other hand, G. 2017-58 variety showed the lowest number of internodes/plant (10.67 and 12.00 internodes/plant) in both seasons, respectively.

Table 5. Effect of SCMV disease on number of internodes/plant of two sugarcane varieties in 2018/19 and 2019/20 growing seasons, under field conditions.

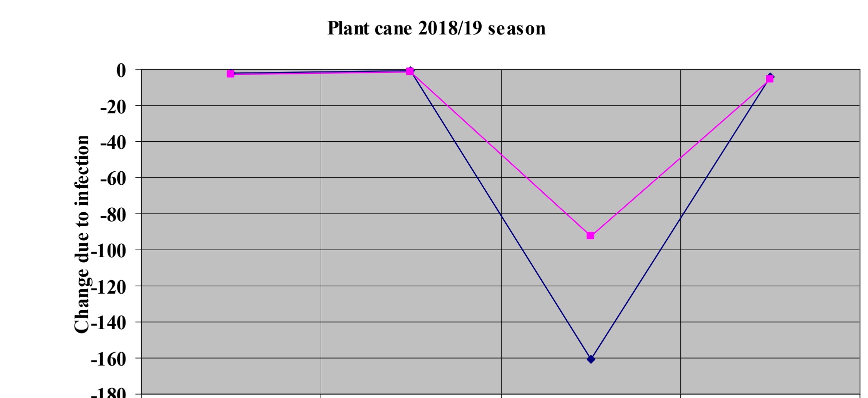
Seasons			2018/19		
Varieties	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	21.20	16.80	19.00	4.40	20.75
G.2017-58	16.44	10.67	13.56	5.77	35.10
Mean	18.82	13.73	16.28	5.09	27.05
			2019/20		
	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	22.45	15.20	18.83	7.25	32.29
G.2017-58	18.89	12.00	15.45	6.89	36.47
Mean	20.67	13.60	17.14	7.07	34.20
L.S.D. at 0.05					
	2018/19	2019/20			
Varieties (A)	0.65	0.11			
Infected (B)	0.55	0.12			
Interaction (A×B)	0.78	0.17			

2.2. Effect of SCMV disease on juice quality of sugarcane plants:

Effect of infection with SCMV disease on juice quality parameters of G.T.54-9 and G.2017-58and positively and negatively changes in juice quality parameters were recorded (Fig. 5) in the successive seasons 2018/19 and 2019/20.

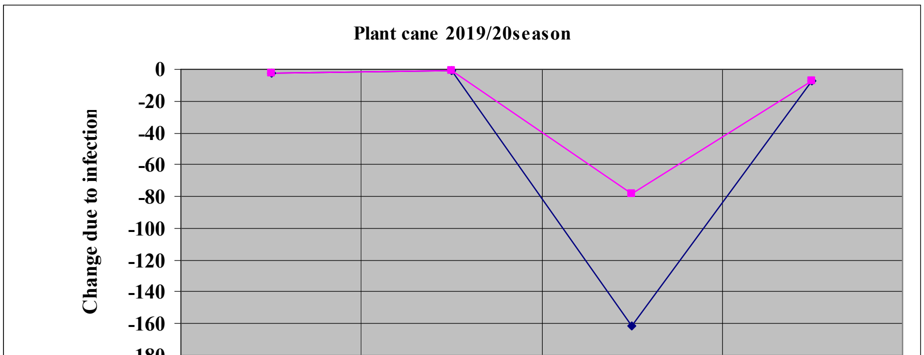
2.2.1. Juice extraction kg.:

Results in Table (6) explained that the infection of sugarcane plants with SCMV significantly decreased in juice extraction kg., in two tested sugarcane varieties in the two growing seasons. The highest juice extraction kg., (2.83 and 3.72kg.) was recorded in G.T. 54-9 variety in the first and second season, respectively. As compared to juice extraction kg. in healthy and infected plants, reduction in juice extraction kg. of the G.T. 54-9 variety reached 3.20 and 3.70 kg. in the first and second seasons, respectively, with percentage of reduction amounted by 72.23 and 66.43 kg., in both tested seasons, respectively. The least juice extraction kg. (2.60 and 3.45 cm.) was recorded in G. 2017-58 variety in the first and second seasons, respectively. In comparing to healthy and diseased plants of G. 2017- 58 variety, reduction in juice extraction kg., amounted by 2.00 and 3.50 kg., in two tested seasons, respectively, and percentage of reduction in juice extraction kg., amounted by 55.56 and 67.31 kg., in both tested seasons, respectively. Such results are in agreement with those reported by Viswanathan andBalamuralikrishnan(2005) and Bagyalakshmi*et al.* (2019).



	Number of millable cane/m2	Stalk diameter (cm.)	Stalk length (cm.)	Number of internodes/plant
G,T,54-9	-2,00	-0,44	-160,50	-4,40
G, 2017-58	-2,66	-1,31	-92,23	-5,77

Growth patrameters



	Number of millable cane/m2	Stalk diameter (cm.)	Stalk length (cm.)	Number of internodes/plant
G,T,54-9	-2,66	-0,55	-161,58	-7,25
G, 2017-58	-2,33	-1,01	-77,94	-6,89

Growth patrameters

Fig. 4. Changes in growth parameters associated with infection with SCMV disease of G.T.54-9 and G. 2017 -58 varieties in 2018/19 and 2019/20 growing seasons.

On the other hand, under infection of two sugarcane varieties with SCMV disease juice extraction kg., was lower in plants infected with SCMV than healthy ones in the first and second seasons. The juice extraction kg. decreased by 2.60 and 3.60 kg. in the first and second seasons, respectively. Percentage of reduction reached 64.68 and 66.79% in both tested seasons, respectively.

In relation to the interaction between sugarcane varieties and infection with SCMV, the highest juice extraction kg.(4.43 and 5.57 kg.) was recorded in G. T.54-9 variety in the first and second seasons, respectively, while the lowest juice extraction kg.,(1.23 kg) was recorded for G. T.54-9 variety in the first season, while in the second season reached (1.70 kg) for G. 2017- 58variety in the second season.

Table 6. Effect of SCMV disease on juice extraction percentage of two sugarcane varieties in 2018/19 and 2019/20 growing seasons, under field conditions.

Seasons			2018/19		
Varieties	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	4.43	1.23	2.83	3.20	72.23
G.2017-58	3.60	1.60	2.60	2.00	55.56
Mean	4.02	1.42	2.72	2.60	64.68
			2019/20		
	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	5.57	1.87	3.72	3.70	66.43
G.2017-58	5.20	1.70	3.45	3.50	67.31
Mean	5.39	1.79	3.59	3.60	66.79
L.S.D. at 0.05					
	2018/19	2019/20			
Varieties (A)	0.13	0.05			
Infected (B)	0.12	0.09			
Interaction (A×B)	0.17	0.12			

Results showed that infection of sugarcane plants with SCMV significant decreased in juice extraction kg., in tested sugarcane plants infection with SCMV in the two growing seasons.

2.2.2. Sucrose of juice percentage

The results in Table (7) proved that, increased of sucrose percentage in juice of two tested sugarcane varieties in both seasons. In the first season, the high sucrose percentage (20.50 and 19.11%) was recorded in G.T. 54-9 variety in the first and second season, respectively, while the low sucrose percentage (14.54 and 13.35%) was recorded in G. 2017- 58 variety in both tested season, respectively.

The sucrose content of juice increased in infected sugarcane plants in the two tested seasons compared with healthy sugarcane plants.

Data also demonstrated that the interaction effect between two sugarcane varieties and virulence of SCMV pathogen on sucrose percentage of sugarcane juice was significant in the first and second season. The highest sucrose percentage (20.86 and 19.57%) was recorded in G.T. 54-9 variety infected with SCMV pathogen in the first and second season, respectively.

On the other hand, the lowest sucrose percentage (13.40 and 12.64%) was recorded in G. 2017- 58 variety non-infected with SCMV in both tested seasons, respectively. These results agreement with Addy *et al.* (2017), who announced that sucrose phosphate synthase (SPS) activity was in contrary to the sucrose content in the leaves. SPS activity was drastically reduced in inoculated leaves by about 50%, while the sucrose content significantly increased in inoculated leaf by about 35%, and suggest that the lower activity of SPS in infected leaves occurred as a result of the inhibition of the plant to produce normal levels of SPS protein, less abundant SPS production caused lower SPS activity in leaves.

Since SPS plays a crucial role in sucrose biosynthesis, incorporating with Sucrose Phosphate Phosphatase (SPP) (Chen *et al.* (2005) and Lunn and Rees (1990)). The increased activity of SPS would result in a higher sucrose accumulation (Verma *et al.* 2011). In contrast. our result showed a lower SPS activity.

Table (7): Effect of SCMV disease on sucrose percentage of two sugarcane varieties in 2018/19 and 2019/20 growing seasons, under field conditions.

Seasons			2018/19		
Varieties	Healthy	Infected	Mean	Increase	Increase%
G.T. 54-9	20.14	20.86	20.50	0.72	3.57
G.2017-58	13.40	15.67	14.54	2.27	16.94
Mean	16.77	18.27	17.52	1.50	8.94
			2019/20		
	Healthy	Infected	Mean	Increase	Increase%
G.T. 54-9	18.65	19.57	19.11	0.92	4.93
G.2017-58	12.64	14.06	13.35	1.42	11.23
Mean	15.56	16.82	16.19	1.26	8.10
L.S.D. at 0.05					
	2018/19	2019/20			
Varieties (A)	1.02	0.07			
Infected (B)	0.58	0.12			
Interaction (A×B)	0.83	0.18			

2.2.3. Brix percentage of juice:

Data in table (8) assessed that the brix percentage of juice in tested sugarcane varieties markedly decreased in infected plants compared with non-infected plants.

It could be noticed that the high brix percentage (23.89 and 23.43%) was recorded in G.T. 54-9 variety in the first and second season, respectively, while the low brix percentage (17.78 and 17.18 %)

was recorded in G. 2017- 58 variety. Infection of two sugarcane varieties with SCMV decreased brix percentage at compared with healthy plants in both tested seasons.

Regarding to the interaction between sugarcane varieties and the infection with SCMV on brix percentage, significant effect was observed in the first and second season. However. it was clear in both tested seasons that infection of sugarcane varieties with SCMV caused reduction in brix percentage compared with control treatment. The highest brix percentage (24.41 and 23.68%) was recorded in G.T. 54-9 variety in the first and second season, respectively. The lowest brix percentage (16.99 and 16.87%)was recorded in G. 2017- 58 variety in two tested seasons, respectively.

Table (8): Effect of SCMV disease on brix percentage of two sugarcane varieties in 2018/19 and 2019/20 growing seasons, under field conditions.

Seasons	2018/19				
Varieties	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	24.41	23.36	23.89	1.05	4.30
G.2017-58	18.57	16.99	17.78	1.58	8.51
Mean	21.49	20.17	20.83	1.32	6.14
	2019/20				
	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	23.68	23.17	23.43	0.51	2.15
G.2017-58	17.48	16.87	17.18	0.61	3.49
Mean	20.58	20.02	20.30	0.56	2.72
L.S.D. at 0.05					
	2018/19	2019/20			
Varieties (A)	0.18	0.01			
Infected (B)	0.22	0.04			
Interaction (A×B)	0.32	0.05			

2.2.4. Purity percentage of juice:

The results in Table (9) established that infection with the disease significantly affected purity percentage of sugarcane juice in tested sugarcane varieties in the first and second seasons. The highest purity percentage (93.74 and 89.01%) was recorded in juice of G.T. 54-9 variety in both tested seasons, respectively, while the lowest purity percentage (86.32 and 82.93%) was recorded in G. 2017- 58 variety in the first and second seasons, respectively. The data also revealed that the purity percentage of juice of sugarcane plants infected with SCMV pathogen was decreased in both tested seasons. The purity percentage in juice of tested sugarcane varieties was lower in infected plants than in non-infected plants in both seasons. It decreased by 2.50% in the first season and

5.87% in the second season compared with non-infected plants in both tested seasons.

The interaction effect of sugarcane varieties and infected with SCMV was significantly decreased in both seasons. In the first season, the highest purity percentage (94.00 and 92.01%) was recorded in G.T. 54-9 variety non- infected with SCMV in the first and second seasons, respectively, while the lowest reduction in purity percentage (84.07and 80.07%) was recorded in G. 2017- 58variety in the first and second seasons, respectively.

Table (9): Effect of SCMV disease on purity percentage of two sugarcane varieties in 2018/19 and 2019/20 growing seasons, under field conditions.

Seasons	2018/19				
Varieties	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	94.00	93.48	93.74	0.52	0.55
G.2017-58	88.56	84.07	86.32	4.49	5.07
Mean	91.28	88.78	90.03	2.50	2.74
	2019/20				
	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	92.01	86.00	89.01	6.01	6.53
G.2017-58	85.79	80.07	82.93	5.72	6.67
Mean	88.90	83.03	85.97	5.87	6.60
L.S.D. at 0.05					
	2018/19	2019/20			
Varieties (A)	1.09	0.07			
Infected (B)	1.97	0.10			
Interaction (A×B)	2.79	0.14			

2.2.5. Sugar recovery percentage:

Data presented in Table (10) confirmed that the infection with SCMV pathogen in the first and second seasons significantly affected sugar recovery percentage compared with non-infected sugarcane plants. In general, the highest sugar recovery percentage (14.57 and 13.26%) was recorded in G.T. 54-9 variety in the first and second seasons, respectively. The low of sugar recovery percentage (9.81 and 8.94%) was recorded in G. 2017- 58 variety in first and second seasons. respectively.

With respect to the effect of SCMV pathogen on sugar recovery percentage, clearly data show that significant differences were found between the effects of SCMV pathogen on sugar recovery percentage in both tested seasons. Furthermore, reduction of sugar recovery percentage (1.04 and 1.18%) was recorded at compared to healthy and infected sugarcane plants in the first and second seasons, respectively.

In relation to the interaction between the infection with the SCMV pathogen and two tested sugarcane varieties, the highest sugar recovery percentage (14.80and 13.79%) was recorded in G. G.T. 54-9 variety, in both tested seasons, respectively. The lowest sugar recovery percentage (9.00 and 8.29%) was recorded in G. 2017- 58 variety in the first and second seasons, respectively.

Table (10): Effect of SCMV disease on sugar recovery percentage of two sugarcane varieties in 2018/19 and 2019/20 growing seasons. under field conditions.

Seasons			2018/19		
Varieties	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	14.80	14.33	14.57	0.47	3.18
G.2017-58	10.62	9.00	9.81	1.62	15.25
Mean	12.71	11.67	12.19	1.04	8.18
			2019/20		
	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	13.79	12.72	13.26	1.07	7.76
G.2017-58	9.59	8.29	8.94	1.30	13.56
Mean	11.69	10.51	11.10	1.18	10.09
L.S.D. at 0.05					
	2018/19	2019/20			
Varieties (A)	0.61	0.01			
Infected (B)	0.46	0.03			
Interaction (A×B)	0.64	0.04			

2.2.6. Pol percentage of juice:

Data in Table (11) cleared that pol percentage of juice was significantly reduced on two tested sugarcane varieties infection with SCMV pathogen. The high pol percentage (15.57 and 14.99%) was recorded in G.T. 54-9 variety in both season, respectively, while the low pol percentage (11.51 and 10.96%) was recorded in G. 2017- 58 in the first and second seasons, respectively.

Compared with non-infected plants (control), pol percentage significantly decreased in plants infected with the tested pathogen in both seasons. On the other hand, reduction percentage in pol percentage amounted by (6.16 and 2.74%) at compared to infected and healthy plants in the first and second seasons, respectively.

Interaction between the infection with SCMV and two tested sugarcane varieties on pol percentage was significant reduction in the first and second seasons. In the first season, the highest reduction in pol percentage (1.13 and 0.65%) was recorded in G. 2017- 58variety in both tested seasons, respectively, while the lowest reduction in pol percentage (0.59 and 0.08 %) was recorded in G.T. 54-9 in the first and second seasons, respectively.

Data cited that infected of tested sugarcane verities with SCMV disease significantly decreased of some quality parameters of cane juice. Moreover, the lower quality parameters of sugarcane juice in infected plants might be due to differences in growth yield. In general, the reduction in cane juice quality brix, purity, pol and sugar recovery of sugarcane juice due to SCMV supported by many authors (Gonçalves *et al*. 2012, Viswanathan 2016 and Addy *et al*. 2017). The reduction in brix, purity, pol and sugar recovery of sugarcane juice varied according to the levels of SCMV pathogen and severity of infection (**Addy *et al*. 2017).**

Table (11): Effect of SCMV disease on pol percentage of two sugarcane varieties in 2018/19 and 2019/20 growing seasons, under field conditions.

Seasons			**2018/19**		
Varieties	**Healthy**	**Infected**	**Mean**	**Reduction**	**Reduction%**
G.T. 54-9	15.86	15.27	15.57	0.59	3.72
G.2017-58	12.07	10.94	11.51	1.13	9.36
Mean	13.97	13.11	13.54	0.86	6.16
			2019/20		
	Healthy	**Infected**	**Mean**	**Reduction**	**Reduction%**
G.T. 54-9	15.03	14.95	14.99	0.08	0.53
G.2017-58	11.28	10.63	10.96	0.65	5.76
Mean	13.15	12.79	12.97	0.36	2.74

L.S.D. at 0.05

	2018/19	**2019/20**
Varieties (A)	0.07	0.19
Infected (B)	0.16	0.21
Interaction (A×B)	0.23	0.29

2.2.7. Reducing sugar percentage:

Results in Table (12) detected that the reducing sugar percentage of the two tested sugarcane varieties was increased significantly affected by infection with the SCMV disease in both tested seasons, the highest reducing sugar percentage (1.46 and 1.48%) was recorded in G. 2017- 58 variety in the first and second seasons, respectively. On the other hand, the lowest reducing sugar percentage (1.23 and 1.08%) was recorded in G.T. 54-9 variety in both tested seasons. respectively. Reducing sugar percentage in sugarcane juice was significantly increased at infection with SCMV in both seasons. The reducing sugar percentage was higher in infected sugarcane plants than in non-infected plants in both seasons. In regard to the interaction between the effect of infection with SCMV pathogen and sugarcane varieties tested, significant effect on reducing sugar percentage was recorded in the two tested seasons. The highest reducing sugar percentage (1.47 and 1.57%) was recorded in G. 2017- 58 variety infected with SCMV pathogen in the first and second seasons, respectively, while the lowest reducing sugar percentage (1.07 and 1.05 %) was recorded in G.T. 54-9 variety infected with SCMV pathogen in both tested seasons, respectively.

Table (12): Effect of SCMV disease on reducing sugar percentage of two sugarcane varieties in 2018/19 and 2019/20 growing seasons, under field conditions.

Seasons			**2018/19**		
Varieties	**Healthy**	**Infected**	**Mean**	**Increase**	**Increase%**
G.T. 54-9	1.07	1.39	1.23	0.32	29.91
G.2017-58	1.44	1.47	1.46	0.03	2.08
Mean	1.26	1.43	1.35	0.17	13.49
			2019/20		
	Healthy	**Infected**	**Mean**	**Increase**	**Increase%**
G.T. 54-9	1.05	1.10	1.08	0.05	4.76
G.2017-58	1.39	1.57	1.48	0.18	12.95
Mean	1.22	1.34	1.28	0.12	9.84

L.S.D. at 0.05	**2018/19**	**2019/20**
Varieties (A)	0.12	0.03
Infected (B)	0.09	0.05
Interaction (A×B)	0.13	0.08

Reducing sugar percentage in sugarcane juice was significantly increased in infected sugarcane plants with SCMV disease in compared with healthy plants. The increase of reducing sugars in infected plants may be due to the decomposition action of specific enzymes (invertases) produced by the pathogen. Interaction between infected plants with the pathogen and the carbohydrates of the host plants which determines the pathogens ability to produce enzymes capable of degrading the host cell walls and that the pathogen stimulates carbohydrate hydrolytic enzymes such as pectinase, cellulose and amylase, Analysis carbohydrate with these enzymes may be due to increase the reducing sugar content of juice (Osman *et al*. 2014).

2.3. Effect of SCMV disease on yield components of sugarcane plants:

Impact of infection with SCMV disease on yield components of two tested sugarcane varieties, positively and negatively changes in yield components were recorded (Fig. 6) under field conditions in the successive seasons 2018/19 and 2019/20.

2.3.1. Net cane yield (tons/fed.):

The results in Table (13)distinguished that the infection of sugarcane plants with

SCMV significant decreased in net cane yield tons/fed., in two tested sugarcane varieties in the two growing seasons compared to control treatment. The highest net cane yield tons/fed., was recorded in G. 2017- 58 variety (35.75 tons/ fed.) in the first season and (35.28 tons/ fed.) in the second season. Reduction in net cane yield tons/fed., of the same variety amounted by 32.78 tons/ fed., and 40.01tons/ fed., in two

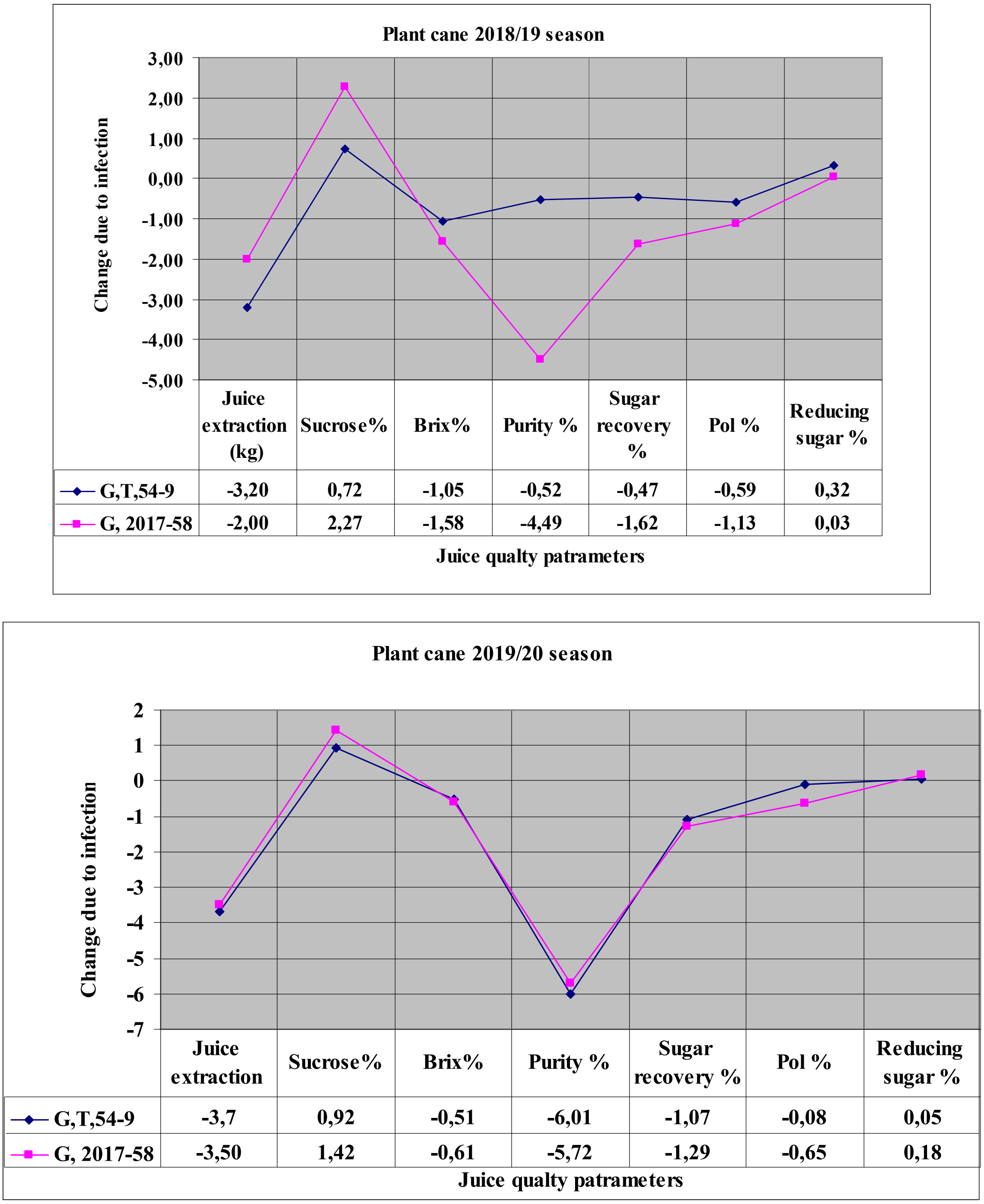


Fig. 5.: Changes in juice quality parameters associated with infection with SCMV disease of G.T.54-9 and G. 2017 58 varieties in 2018/19 and 2019/20 growing seasons.

tested seasons, respectively, and percentage of reduction in amounted 62.87 and 72.38% , in both tested seasons respectively. The lowest net cane yield tons/fed., (30.12 and 30.80 tons/ fed.) was recorded in G.T. 54-9 variety in the first and second seasons, respectively. At compared to healthy and diseased plants of G.T. 54-9 variety. Reduction in net cane yield tons/fed., amounted by (36.22 and 36.01 tons/ fed.) in two tested seasons, respectively. and percentage of reduction in net cane yield tons/fed amounted (75.10 and 73.79%) in both tested seasons, respectively.

Table (13): Effect of SCMV disease on net cane yield tons/fed of two sugarcane varieties in 2018/19 and 2019/20 growing seasons, under field conditions.

Seasons			2018/19		
Varieties	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	48.23	12.01	30.12	36.22	75.10
G.2017-58	52.14	19.36	35.75	32.78	62.87
Mean	50.18	15.69	32.94	34.49	68.73
			2019/20		
	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	48.80	12.79	30.80	36.01	73.79
G.2017-58	55.28	15.27	35.28	40.01	72.38
Mean	52.04	14.03	33.04	38.01	73.04
L.S.D. at 0.05					
	2018/19	2019/20			
Varieties (A)	1.09	0.31			
Infected (B)	1.14	1.26			
Interaction (A×B)	1.61	1.79			

Such results are agreement with Singh *et al.* (1997)who found that SCMV disease causes major problems in most of the sugarcane growing countries and many varieties. Yield losses of cultivation sugarcane infected with the disease reached up to 50 percentage in infected plants of sugarcane when compared to the healthy ones due to infection with SCMV.

Under infection of two sugarcane varieties with SCMV pathogen, the net cane yield tons/fed.was lower in infected plants compared to healthy ones in first and second seasons, net cane yield tons/fed. decreased by (34.49and 38.01 tons/ fed.) in the first and second seasons, respectively. Percentage of reduction reached (68.73 and 73.04%) in both tested seasons, respectively. On the other hand, the interaction between sugarcane varieties and infection with SCMV, the highest net cane yield tons/fed.(52.14 and 55.28tons/ fed.) was recorded in G. 2017- 58 variety in the first and second seasons, respectively, Moerover, the lowest net cane yield tons/fed.,(12.01and 12.79 tons/ fed.) was recorded in G. T.54-9 in the first and second seasons, respectively. Singh *et al.* (2003. 2005) and Gonçalves *et al.*(2012)reported that yield losses ranging from 11 up to 50% in susceptible varieties under severe infection with sugarcane mosaic disease. (Parameswari*et al.* 2013) found that the typical symptoms of SCSMV are similar to those caused by SCMV and estimated yield losses vary from 30–80 %. In general many authors supported that the significant reduction in net cane yield tons/fed., of sugarcane due to infection with SCMV disease. (Agnihotri (1996). Abd El Fattah *et al.* 2005. Viswanathan and Balamuralikrishnan 2005. Gonçalves *et al.* 2012 and Addy *et al.* 2017). The crop yield is significantly reduced (10-22%) when incidence of infection level reaches to 50% (Thorat*et al.* 2015).

2.3.2. Sugar yield tons/fed.:

Data in Table (14) specified that the infection of sugarcane plants with SCMV significant decreased in sugar yield tons/fed., in both tested sugarcane varieties in the two growing seasons, compared to healthy plants. G.T. 54-9 variety recorded the highest sugar yield tons/fed., (4.35 and 4.18 tons/ fed.) in the first season and second season, respectively.

Table (14): Effect of SCMV disease on sugar yield tons/fed. percentage of two sugarcane varieties in 2018/19 and 2019/20 growing seasons, under field conditions.

Seasons			2018/19		
Varieties	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	6.91	1.78	4.35	5.13	74.24
G.2017-58	4.71	2.06	3.39	2.65	56.26
Mean	5.81	1.92	3.87	3.89	66.95
			2019/20		
	Healthy	Infected	Mean	Reduction	Reduction%
G.T. 54-9	6.73	1.63	4.18	5.10	75.78
G.2017-58	4.59	1.50	3.05	3.09	67.32
Mean	5.66	1.57	3.62	4.09	72.26
L.S.D. at 0.05					
	2018/19	2019/20			
Varieties (A)	0.63	0.38			
Infected (B)	0.85	0.69			
Interaction (A×B)	1.20	0.98			

Reduction in sugar yield tons/fed., of the same variety amounted by (5.13 and 5.10 tons/ fed.)in two tested seasons, respectively, and percentage of reduction in amounted (74.24 and 75.78%) in both tested seasons, respectively. The lowest sugar yield tons/fed., (3.39 and 3.05 tons /fed.) was recorded in G. 2017- 58 variety

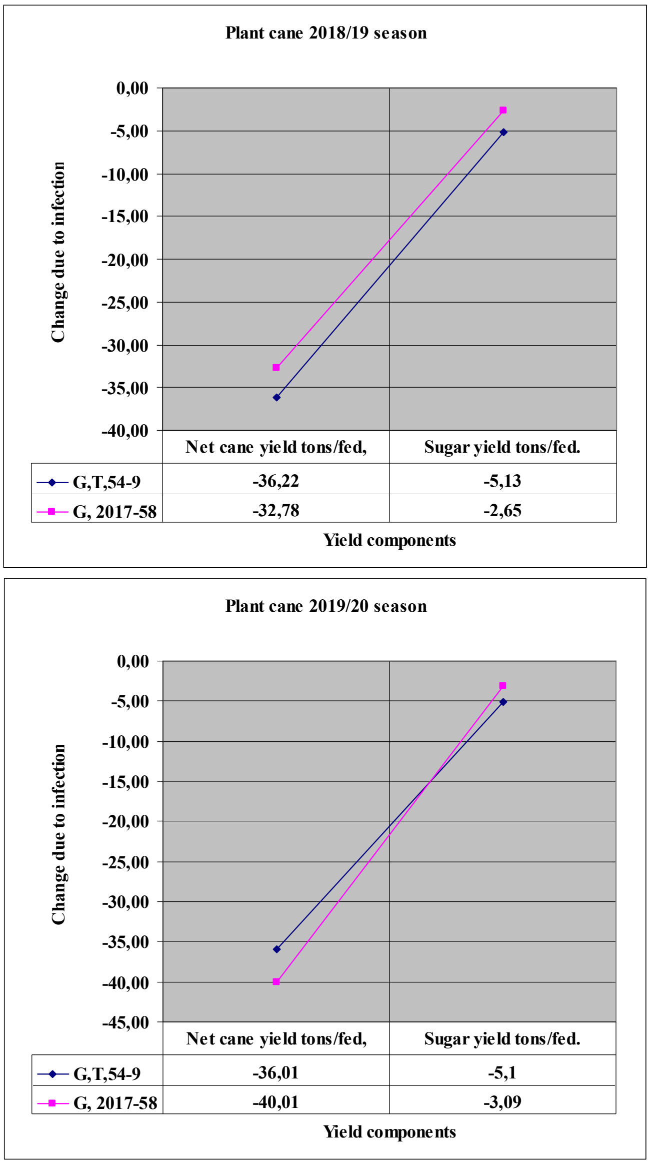


Fig. 6.: Changes in yield components associated with infection with SCMV disease of G.T.54-9 and G. 2017 58 varieties in 2018/19 and 2019/20 growing seasons.

in the first and second seasons, respectively. in the first and second seasons, respectively. Reduction in sugar yield tons/fed., amounted by (2.65 and 3.09 tons/ fed.) in two tested seasons, respectively, compared to healthy and infected plants variety. Percentage of reduction in sugar yield tons/fed., amounted (56.26 and 67.32%) in both tested seasons, respectively. These data are consistent with the observation by Thorat*et al*. (2015) who found that**,** under favorable conditions of severe mosaic infection in a susceptible variety, reduction in sucrose yield may be as high as 42%. Sugar yield tons/fed., was lower in infected plants compared to healthy ones under infection of two sugarcane varieties with SCMV pathogen in the first and second seasons. Sugar yield tons/fed of sugarcane decreased by (3.89 and 4.09 tons/ fed.) in the first and second seasons, respectively.

Reduction percentage reached (66.95 and 72.26%), in both tested seasons respectively. Putra *et al*. (2014) recorded a reduction in sugar yield of about 19-21% due to infection with SCSMV disease in some sugarcane varieties.Singh *et al.*(2003)assessed cane commercial cane sugar (CCS) reduction in cvsCoLk 8102, CoPant 90223 and CoS 767 due to mosaic in the sub tropical region, they found 11.71 and 9.84% reduction in CCS in plant and ratoon crops respectively. The interaction between sugarcane varieties and infection with SCMV, the highest sugar yield tons/fed (6.91 and 6.73tons/ fed.) was recorded in G. T.54-9 variety in the first and second seasons, respectively, while the lowest sugar yield tons/fed., (1.78 tons /fed.)was recorded in G. T.54-9 variety in the first season, while in the second season was recorded in G. 2017- 58 variety.

CONCLUSION

From the results mentioned above, it could be concluded that there was an increase of SCMV incidence and distribution in Esna district from season to another .Occurrence of the disease and the more widespread is due to the transmissibility of the disease through cane cuttings and transportation of infected plant materials from one area to other areas. There are 4 locations (El-trakee (Awladhamid) (EN4), Elfarsea (30-115 El-motawlelgrby) (EN7), El-Dkera (Mohamed Hassan) (EN18) and El-Adima (Abd-elrahman) (EN19)) were free of infection with SCMV and 5 locations were infected by such disease in all tested seasons. Therefore, it could be planted G.T.54-9in these locations.

Findings of survey indicated that the virus might cause more yield loss in farmers fields so must be cultivation virus-free planting materials for enhance cane yield and sucrose yield in G.T.54-9 variety. Maintaining virus-free crop in the field would ensure improvement in the productivity of the crop as well as increase in sucrose yield per unit area.Cultivation of infected sugarcane plants with SCMV disease caused a significant reduction to the growth, juice quality parameters and yield component in G.T.54-9 and G.2017-54 varieties. G.T.54-9 variety highest affected by this disease in compared with G.2017-54 variety.To control the virus must use of virus-free cane cuttings, Cultivation of areas severely affected by mosaic disease with seeds taken from healthy fields and planting resistant varieties.

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