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Original article

Mutagenic effect of ultraviolet rays on sex expression in summer squash genotypes

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Abstract

The present study aimed to induce genetic variations within the control of sex expression in summer squash using ultraviolet rays (UV) as a physical source of mutations in plants. Because the sex expression in summer squash is fundamentally controlled mainly by genetics and partially by the environment. Therefore, this study tries to increase floral differentiation of female flowers, as well as decrease male flowers developed per plant, because summer squash usually exhibit more male flowers and lower female flowers. This will cause decreases in fruits yield per plant. This study was designed in a randomized complete block design with a factorial investigation. It was included four genotypes of summer squash subjected to four exposure periods of UV rays, with three repetitions for each experimental unit. The results showed that genotype number four increased the features of female flowers by 28% and 14% at 4 and 8 minutes of exposure period, respectively. The 12 – minute exposure period significantly increased floral differentiation among all genotypes toward male flowers developed per plant. Meanwhile, genotype number two enhanced floral differentiation toward female flowers by 14% at 8 minutes of exposure period, indicating that these few periods of exposure to UV irradiation may be responsible for induced benefit mutations in cucurbits affected on sex expression, as it induced high number of female flowers. The results indicated that UV irradiation had a direct role in promoting floral differentiation as it inducement higher female flowers in some genotypes leading to improve floral characteristics, as a consequence increased fruits yield per plant.

Keywords

Summer squash, ultraviolet irradiation, sex expression, femaleness, homogeneity, heterogeneity, variation coefficient.

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Introduction

Summer squash, *Cucurbita pepo* L. considered as the edible immature fruits, which belongs to the economically important family Cucurbitaceae. It is an important vegetable crop cultivated in Egypt for local consumption, as well as for foreign exporting market. Increasing fruits yield and quality are the main targets for growers. It is a cross – pollinated crop having a diploid chromosome number (2n = 2x = 40) which planted for its fruits [1].

Ultraviolet rays are part from the electromagnetic spectrum that affects different physiological and morphological processes in the plant population exposure to these rays. It also affects DNA and proteins inside the plant cells [2]. Irradiating pollen grains or seeds by ultraviolet rays with different doses of physical mutagens stimulates the induction of monochromosomal plants. Ultraviolet rays may kill pollen grains leading its to unviable, as well as, unable to pollinate and fertilize the ovary, as a consequence it helps to develop virginity fruits. Irradiation technology and genetic structures are the main factors in inducing haploid plants [3].

Summer squash generally display high numbers of male flowers and lower numbers of female flowers. This reason leading to lowering its fruit yield. The sex expression in summer squash is fundamentally controlled by genetics and environmental factors e.g. photoperiod, temperature etc. Growth regulators, as well as mutagenic agents can change the sex ratio [4]. Treatment with ethereal increased the number of female flowers from 8.6 to 10.2. The femaleness proportion in summer squash and other monocots of Cucurbitaceae crops are fundamentally display to genetic factors, this leading flowering practice to be highly diverse under different environmental status. [5] proposed that spraying summer squash with ethereal significantly reinforce the yield via increasing the number of female flowers.

Sex determination in cucurbits crops is controlled by a combination of genetic factors, environmental condition, nutritional factors, as well as hormonal factors [6]. Summer squash was very affected by temperatures because the low temperature inhibits the development of male flowers, as well as increase the number of female flowers [7]. Meanwhile, high temperature reduces female flowers into hermaphrodites or male flowers [8].

The sexual expression in *Cucurbita pepo* L. is monoicous, occurring in separate points on the same plant [9]. Female flowers have an elongated ovary are usually less numerous than male flowers. *Cucurbita pepo L*. has two or three sexual phases, starting from the production of male flowers exclusively, alternatively male and female flowers are produced and finally female flowers are developed [10].

To increase the yield of fruits in summer squash some studies used ethylene to achieve sex reversal in cucurbits. The female floral buds need a limit concentration of ethylene to complete formation and maturation without occurrence of premature abortion [11]. Ethylene when applied to cucurbit plants leads to intermediate release of ethylene in plant cells, caused suppression in some of male flowers, which replaced after aborted by female flowers that developed on secondary buds [12]. Summer squash cultivated in spring usually formed high number of female flowers and lower male flowers because of lower temperatures and short photoperiods in early spring, which affected on the regular pollination and fruit setting. In summer season, high temperatures and long photoperiods usually exhibit the development of high male flowers and reduce female flowers. This will cause decreases in fruits yield formed on summer squash [11]. Employment of any mutagenic or chemical agents, as well as manipulating temperature and / or illumination will affect sex expression in *Cucurbita pepo* L.

Egypt is one of the most densely populated country in Africa having over 105 million people. To meet up the food requirements for its uprated population, the most effective methods were used to ensure food security, one of them is mutation breeding because there is urgent need to increase crop productivity per unit areas of land via varietal improvement. Quantitative and qualitative assessment of the variation degree in genetic resources is important for summer squash breeding programs [13]. Considering the above points of view, the present investigation has been under taken to determine diversity induced by physical mutagens as ultraviolet rays in the sex expression of summer squash which affect on fruits yielding, to meet up the requirements of food from this crop to ensure food security.

Materials and methods

This study was conducted in the Agri-field of Genetic Department inside the campus of Mansoura University during the period of summer season 2022. Four genotypes of squash were used in this study as shown in Table 1.

Table 1. Summer squash genotypes used in this study and their references.

Genotypes	Designation
Alexandarani	Genotype 1
1116228	Genotype 2
1116232	Genotype 3
1116237	Genotype 4

Ultraviolet irradiation

Seeds of four genotypes of summer squash were first soaked in water for 12 hours before UV–irradiation to increase the mobility and the effect of free radicals and oxy-

gen with physical mutagenic agents [14]. The seeds were exposed to UV rays for periods; 0, 4, 8 minutes with the laminar cabinet supported with UV lamp as an artificial source. The UV laminar chamber was located in the Laboratory of Microbial Genetics, Faculty of Agriculture, Mansoura University. The spectrum of UV – radiation used in this study belongs to high energy source named UV-B (280- 320 nm) which is higher effective than UV A for induced mutations [15]. The spectrum of UV lamp used in this study was 300 nm. Therefore, it was classified as UV- B. Each minute of exposure time to UV– radiation equal 188.2 joules/m^2) according to [16]. The joules are defined as the amount of energy extracted when a force of one newton is applied over a displacement of one meter which is equivalent to one watt of power radiated for one second.

Experimental design

The experiment was established under a randomized complete block design with three replicates and 4 by 4 factorial arrangement. Irradiated and nonirradiated seeds were cultivated in rows 70 cm wide and three meters long. Two seeds were planted per hill on one side of the ridge at a distance 50 cm apart and 80 cm between the rows. All agricultural practices were carried out according to the recommendations of Egyptian Ministry of Agriculture for summer squash production [17].

Floral traits: At flowering period, a random sample of five plants from each plot was labeled. The number of female and male flowers were counted at two days intervals all over the flowering period. Sex ratio was calculated according to [18], as well as [19] using the following equation,

Sex ratio= Number of female flowers / Number of male flowers

However, femaleness was calculated according to [20] using the following equation,

Femaleness = Number of female flowers / Number of female flowers + Number of male flowers

Homogeneity assays

The degree of genetic variations induced was expressed as homogeneity between different UV doses according to [21]**,** using the following formula:

Coefficient of variation = Standard deviation / Grand mean×100

Statistical analysis

Results are the mean values of five biological replicates from each plot. All the data were subjected to the analyses of variance to test the significance of differences between the means using F- test. Furthermore, least significant difference (LSD) was used to test the differences between means at 0.05 and 0.01 levels of probability according to [21]**.**

Results and discussion

Summer squash harboring two kinds of flowers, male and female flowers which are located on the same plant. The femaleness ratio in most monoecious cucurbit crops was subjected mainly to genetics and partially to the environment. The ratio of pistillate to staminate flowers in summer squash is a very important economic trait since the total fruit yield significantly depends upon this ratio. Therefore, female flowers developed is a significant factor influencing plant reproduction, as well as fruits yield. Exogenous application with ultraviolet irradiation may have tremendous effects on sex expression and flowering in summer squash, may be leading to increase the number of female flowers via suppression the development of some male flowers, and stimulate the development of female flowers, without any deleterious effect on the environment and human health. Therefore, this study tries to change the sex expression in summer squash toward femaleness via subjected the seeds to ultraviolet irradiation to exhibit more female flowers and fewer male flowers. This will cause increases of its fruits yield.

Sex expression

The results in Table 2 shows that the effect of ultraviolet irradiation on sex expression at the doses of 4 and 8 minutes is insignificant by chi square. However, the genotype 2 and genotype 4 increased the number of female flowers by 14% at the dose of 8 minutes of UV irradiation. In addition, the genotype 4 increased the number of female flowers by 28% at the dose of 4 minutes. These results indicated that the genotype 4 increased the number of female flowers by 28% and 14% at the doses of 4 and 8 minutes of ultraviolet irradiation, respectively. Meanwhile, at the dose of 12 minutes all genotypes were significantly increased the number of male flowers in comparison with the number of female flowers. This indicated that the node location of the first male flowers was decreased leading the number of male flowers increased. Different doses of ultraviolet irradiation had different effects on female flowers inducement. Therefore, the low doses of ultraviolet irradiation may increase the number of female flowers depending on the genotype respond to irradiation. These results agreed with (22), who found that floral differentiation in cucumber at five or six – leaf stage cannot be changed the sex expression of floral bud via the chemical regulator. Although, chemical regulator may change only the sex expression of floral buds up to 10^{th} node.

Table 2. Effect of exposure time to UV- irradiation on sex ratio in M_1 generation of summer squash.

Exposure time of UV irradiation (min)												Genotypes
12			8			4			0			
X2	MF	FF	X2	MF	FF	X2	MF	FF	X2	MF	FF	
3.96*	24	12	3.57IS	18	8	0.21IS	14	12	0.31IS	15	12	Genotype 1
11.27**	28	8	0.74IS	12	16	1.14IS	21	15	0.21IS	18	17	Genotype 2
6.66**	23	8	1.28IS	21	14	3.65IS	22	11	0.36IS	16	13	Genotype 3
7.40**	27	10	0.63IS	14	18	1.66IS	10	18	6.06*	24	10	Genotype 4

FF = Number of female flowers / plant, MF = Number of male flowers / plant, X^2 = calculated Chi square, IS = Insignificant differences and *, ** = Significant at 0.05 and 0.01 levels of probability, respectively.

Increasing the number of female flowers at the lower doses of UV irradiation as shown by genotype 2 and genotype 4 is a critical factor influencing plant reproduction as well as crop yield. This agreed with (23), who found that exogenous application with growth regulators as ethylene – releasing compounds have tremendous effects on sex expression and flowering in cucurbits leading to suppress the development of male flowers or increase the number of female flowers. [6] found that ethylene is the basic hormone affecting on sex expression in Cucurbitaceae which proved significant increase in the production of female flowers above male flowers, as well as increased femaleness percentage in cucurbit crops. In this study, some genotypes as genotypes number 2 and 4 were positively respond to the lower doses of UV irradiation as 4 and 8 minutes, which leading to increase the number of female flowers, as well as femaleness percentage, on the same time reduce the number of male flowers developed.

Maximized the number of female flowers and femaleness percentage is a critical factor in Cucurbitaceae influencing crop yield. Therefore, (24) found that hybrid plants produced more ethylene leading to increase female flowers through female buds of Cucurbitaceae because they are produced high concentration of ethylene than that produced by male buds. In this respect, the lower doses of UV irradiation may be attributed to increase the amount of ethylene production to be gained the maximum number of female flowers and femaleness percentage in some genotypes. This may be responsible for the flower induction which affecting on sex expression in cucurbits. These results might be attributed to the importance role of mutagenic agents on physiological processes that promote sex expression and consequently increased the number of female flowers developed, as well as increased sex ratio of femaleness.

Data presented in **Table 3** reveals that the sex ratio of femaleness in genotype 4 was increased by 70% and 38% at the doses of 4 and 8 minutes of UV irradiation, respectively. In addition, the dose of 8 minutes increased the sex ratio in genotype 2 by 45%. However, the differences in sex ratio among the four genotypes were insignificant at all exposure periods, except for the number of female flowers which showed significant differences between genotypes at 8 minutes of exposure time. These results stated that the dose of 8 minutes stimulate female flowering in some genotypes as genotype number two and number four which reflected improving female flowering with the positive influence via improve floral characteristics.

The results obtained herein agreed with (25), who stated that foliar application of potassium on squash plants maxi-

Table 3. Interaction between genotypes and exposure periods to UV irradiation on the number of female and male flowers.

Exposure periods (minutes)						Genotypes	
0			4				
FF	MF	Sex ratio	FF	MF	Sex ratio		
12	15	0.80	12	14	0.85	Genotype 1	
17	18	0.94	15	21	0.71	Genotype 2	
13	16	0.81	11	22	0.50	Genotype 3	
10	24	0.39	18	10	1.70	Genotype 4	
IS	IS	IS	IS	IS	IS	F- test	
7.92	6.09	0.26	5.99	14.70	1.21	0.05	L.S.D
12.0	10.47	0.39	9.09	22.30	1.83	0.01	

Exposure periods (minutes)						Genotypes	
8			12				
FF	MF	Sex ratio	FF	MF	Sex ratio		
8	18	0.44	12	24	0.50	Genotype 1	
16	12	1.45	8	28	0.25	Genotype 2	
14	21	0.66	8	23	0.35	Genotype 3	
18	14	1.38	10	27	0.38	Genotype 4	
**	IS	IS	IS	IS	IS	F- test	
3.57	8.39	2.95	7.46	9.92	2.96	0.05	L.S.D
5.41	12.72	4.47	11.30	15.02	4.48	0.01	

FF = Number of female flowers/plant, MF= Number of male flowers/plant,

IS= Insignificant differences and *, ** = Significant at 0.05 and 0.01 levels of probability, respectively.

mized the number of female flowers and minimized male flowers, as well as sex ratio was also increased. Furthermore, (26) reported that ethylene increased female flowers as a consequence shifted sex expression towards femaleness. These effects may be due to slightly inhibited vegetative growth, stimulate carbohydrate biosynthesis, as well as reduced respiration caused to enhanced the formation of pistillate flowers. In this respect, (11) decided that ethylene released by cucurbit plants controlled the two sexual phases of development and the number of pistillate to staminate flowers developed per plant, as well as regulate the formation of carple in squash female flowers.

The results obtained in this study are in harmony with (18), who found that the different periods of exposure time to radiation intensity did not reflect the significant limit on the characteristics of sex ratio, as a consequence the number of fruits per plant. This appeared that the exposure time of eight minutes to UV irradiation produced the higher number of female flowers for each plant from the genotypes number 2 and 4, which amounted to 14.28% and 12.5% increase above the male flowers, respectively. Although, 12 minutes of exposure period to UV irradiation produced the highest number of male flowers per plant that reached to 49.02 % increase above the female flowers. Meanwhile, the zero minute of exposure treatment produced the lowest reading of female flowers than that of male flowers developed per plant for all genotypes which reached to 40.38 % increase of male flowers above the female flowers. These results indicated that the doses of 4 and 8 minutes of exposure time to UV irradiation were superior to change sex ratio in the positive direction of increased the number of female flowers per plant.

Variation coefficient of femaleness

It is clear from the data in **Table 4** that UV irradiation had an important role in femaleness ratio in the genotype 2 at 8 minutes of exposure time, as well as genotype 4 at 4 and 8 minutes of exposure time to UV irradiation. In this respect, genotype 2 subjected to 8 minutes of exposure time increased femaleness percentage by 59%. However, genotype 4 exposed to 4- and 8-minutes increased femaleness percentage by 65% and 58%, respectively. This indicated that UV irradiation had a direct role in promoting flowering in cucurbit plants as resulting higher female flowering in some genotypes, as well as improve floral characteristics [27]**.** This reflected positive influence of lower doses of UV irradiation to increase the concentration of ethylene released by cucurbit plants leading to increased female flowers to be shifted sex expression toward femaleness via enhanced the development of pistillate flowers [26].

The results obtained in this study agreed with (28), who found that female buds of cucurbits produced high concentration of ethylene than those produced by male buds. Therefore,)19) suggested that spraying squash cultivars with ethephon in the early period of growth may be promote and increased the number of female flowers developed per plant, as well as increased femaleness percentage.

Homogeneity in sex expression

The degree of homogeneity was estimated depending upon coefficient of variability which applied to assess the magnitude of variation resulted from UV irradiation within every genotype **(Table 4)**. For sex ratio, estimated coefficient of variation was ranged from 0.109 to 0.150 for genotype 1 which lower than the check value (0.250) of zero – minute exposure. This indicated high homogeneity in sex ratio of genotype 1 which exhibited high uniformity at different doses of UV irradiation.

The coefficient of variation for genotype 2 was ranged from 0.430 to 0.644 which lower than the check value (0.820) of zero – minute exposure to UV irradiation, indicating high homogeneity in sex ratio. Meanwhile, variation coefficient of genotype 3 was ranged from 0.169 to 0.331 compared with the check value (0.330) at zero – minute of radiation. These results indicated that 12 minutes exposure of UV irradiation induced heterogeneity in sex ratio of genotype 3 toward increased the number of male flowers per plant which reached to 73% of the flowers developed per plant.

Estimated coefficient of variance in genotype 4 was ranged from 0.041 to 0.376 compared with the check value (0.080) at zero minute of exposure time to UV irradiation,

Table 4. Femaleness ratio and coefficient of variation for sex ratio of four summer squash genotypes affected by gamma irradiation.

Exposure time (minutes)								Genotypes	
12		8		4		0			
CV	Femaleness	CV	Femaleness	CV	Femaleness	CV	Femaleness		
0.109	0.33 ±0.11	0.150	0.33 ± 0.15	0.125	0.46 ± 0.13	0.25	0.44 ± 0.20	Genotype 1	
0.644	0.21 ± 0.65	0.501	0.59 ± 0.50	0.430	0.42 ±0.43	0.82	0.50 ±0.65	Genotype 2	
0.331	0.27 ± 0.33	0.198	0.40 ± 0.20	0.169	0.36 ± 0.17	0.33	0.43 ±0.26	Genotype 3	
0.373	0.28 ± 0.37	0.376	0.58 ±0.38	0.041	0.65 ±0.04	0.08	0.28 ±0.06	Genotype 4	
	IS		IS		IS		IS	F – test	
	0.83		0.37		0.03		1.18	0.05	LSD
	1.26		0.55		0.04		1.79	0.01	

Is = Insignificant differences CV = Coefficient of variation

Table 5. Coefficient of variation for physiological traits in summer squash genotypes affected by gamma irradiation.

Exposure periods (minutes)						Genotypes
0			4			
Carotenoids in fruits	Total Chl in fruits	Total Chl in leaves	Carotenoids in fruits	Total Chl in fruits	Total Chl in leaves	
1.31	0.40	0.51	0.02	0.06	0.24	Genotype 1
0.07	0.36	0.95	0.43	0.48	0.25	Genotype 2
0.11	0.59	0.79	0.38	0.38	0.14	Genotype 3
0.49	0.59	1.20	0.23	0.34	0.72	Genotype 4
Exposure periods (minutes)						Genotypes
8			12			
Carotenoids in fruits	Total Chl in fruits	Total Chl in leaves	Carotenoids in fruits	Total Chl in fruits	Total Chl in leaves	
0.06	0.09	0.17	0.25	0.09	0.51	Genotype 1
0.56	0.46	0.58	0.66	0.68	1.02	Genotype 2
0.57	0.58	1.05	0.11	0.16	0.56	Genotype 3
0.43	0.46	0.29	0.60	0.34	1.84	Genotype 4

Chl = Chlorophyll

indicating high heterogeneity (0.376) at 8 minutes of exposure time to be shifted sex expression toward femaleness by 8%. Genotype 4 exposed to 12 minutes of UV irradiation showed high heterogeneity (0.373) in sex expression to be shifted toward the number of male flowers developed per plant which reached to 72%. Therefore, the remaining doses showed homogenous genotypes, since they produced coefficient of variance lower than or near to the check value in the control treatment. In general, the degree of homogeneity was varied between doses of UV irradiation within sex ratio.

Homogeneity in chlorophylls

Degree of homogeneity determined for total chlorophyll in leaves upon genotype 1 estimated coefficient of variance ranged from 0.17 to 0.51 compared with the check value (0.51) at zero time of irradiation (Table 5). This indicated high homogeneity in leaves chlorophylls because the doses of radiation gave the lowest variations within genotype 1 lower than or close to the check value, indicated that chlorophylls concentration are more phenotypically uniform at all doses of UV irradiation. Estimated coefficient of variance for total chlorophyll in fruits and carotenoid concentrations in fruits showed high homogeneity with the control treatment of genotype 1 which recorded lowest variations than the check values.

On the other hand, genotype 2 showed coefficient of variance values for total chlorophyll in leaves ranged from 0.25 to 1.02 compared with the check value (0.95), indicated high heterogeneity at 12 minutes of exposure time to UV irradiation, since they gave higher values in coefficient of variations than that of the check value. These results are in harmony with (29), who found that UV irradiation caused damage to the DNA in plant cells. Meanwhile, **)** 30) decided that protoplast size reduction as a result of exposure to UV – C rays or as a result of mutations in chloroplasts DNA. The magnitude of variation within genotype 2 for total chlorophyll in fruits was ranged from 0.46 to 0.68 which higher than the check value (0.36), indicated high heterogeneity in fruits chlorophylls. Meanwhile, estimated coefficient of variance in fruit carotenoids within genotype 2 was ranged from 0.43 to 0.66 compared with the check value (0.07), indicated high heterogeneity in fruit carotenoids, since they gave coefficient of variance higher than the check value.

For genotype 3, the coefficient of variability for total chlorophyll in leaves was ranged from 0.14 to 1.05 compared with the check value (0.79), indicating high heterogeneity at 8 minutes of exposure time to UV irradiation, since it gave higher values in coefficient of variability than that of the check value. The total chlorophyll in fruits within genotype 3 showed coefficient of variations ranged from 0.16 to 0.58 lower than the check value (0.59), indicating high homogeneity which exhibited high uniformity in this trait at all doses of UV irradiation. Meanwhile, fruit carotenoids showed variation coefficient (CV) ranged from 0.11 to 0.57 if compared with the check value (0.11), indicating high heterogeneity at the doses of 4 and 8 minutes of exposure time to UV irradiation, since they gave CV values higher than that of the check value. Although, genotype 3 exposed to 12 minutes of irradiation showed close CV (0.11) with the check value (0.11), indicated high homogeneity since the plants were more phenotypically uniform with that in the control concerning fruit carotenoids.

Estimated coefficient of variance within genotype 4 for total chlorophyll in leaves were ranged between 0.29 to 1.84 compared with the check value (1.20), indicated high heterogeneity at 12 minutes of exposure time to UV irradiation, since they gave higher values of CV than that of the check value. Meanwhile, high homogeneity was obtained at 4 and 8 minutes of exposure to UV irradiation because CV values were lower than the check value. The total chlorophyll in fruits exhibited CV ranged from 0.34 to 0.46 lower than the

Table 6. Coefficient of variation for leaf area and fruits weight per plant in summer squash genotypes affected by gamma irradiation.

Exposure periods (minutes)				Genotypes
0		4		
Leaf area	Fruits weight per plant	Leaf area	Fruits weight per plant	
1.42	0.25	0.30	0.125	Genotype 1
0.09	0.82	0.43	0.430	Genotype 2
0.86	0.33	0.48	0.169	Genotype 3
2.72	0.08	0.60	0.041	Genotype 4
Exposure periods (minutes)				Genotypes
8		12		
Leaf area	Fruits weight per plant	Leaf area	Fruits weight per plant	
0.31	0.150	0.35	0.109	Genotype 1
0.32	0.501	0.24	0.644	Genotype 2
0.69	0.198	1.05	0.331	Genotype 3
0.26	0.376	0.32	0.373	Genotype 4

check value (0.59), indicated high homogeneity which reflected high uniformity with the plants in the control experiment. Meanwhile, estimated CVs for carotenoids in fruits were ranged from 0.23 to 0.60 compared with the check value (0.49), indicated high heterogeneity at 12 minutes of exposure time to UV radiation, since it gives CV high than that of the check value. The other doses of 4 and 8 minutes of exposure time to UV irradiation induced high homogeneity in fruit carotenoids within genotypes 4, because they are recorded CV values lower than the check value, which exhibited high uniformity with the plants in the control experiment. These results agreed with **(**31**)**, who found that 16 new lines of tomato selected from F_2 generation exhibited high homogeneity based on CV values for some vegetative and biochemical traits.

Homogeneity in fruits yield

As shown in **Table 6**, estimated coefficient of variance values for fruits yield per plants were ranged between 0.109 to 0.150 within genotype 1 compared with check value (0.25), indicated high homogeneity in this trait, since they gave CV values lower than that of the check Cvs. The same trend was also shown in leaf area within genotype 1 which indicated high homogeneity in leaf area, since they gave coefficient of variation ranged between 0.30 to 0.35, which lower than in check value (1.42).

The coefficient of variation for fruits yield per plant within genotype 2 was ranged between 0.430 to 0.644 lower than the check value (0.820), indicated high homogeneity in this trait. Meanwhile, the leaf area CVs were ranged between 0.24 to 0.43 higher than the check value (0.09), indicating high heterogeneity, since the treatments of UV irradiation gave CVs higher than that of the check CVs.

Estimated coefficient of variances for fruits yield per plant within genotype 3 were ranged between 0.169 to 0.331 compared with the check value (0.33), indicating high heterogeneity at 12 minutes of exposure time to UV irradiation, as well as, high homogeneity at the lower doses of irradiation. The leaf area within the same genotype showed the same trend at high and lower doses of UV irradiation.

Regarding genotype 4, coefficient of variance for fruits yield per plant was ranged between 0.041 to 0.376 compared with the check value (0.080), indicating high heterogeneity at 8 and 12 minutes of exposure time to UV irradiation, as well as high homogeneity was obtained at 4 minutes of irradiation. Concerning leaf area, high homogeneity was obtained, since the different doses of UV irradiation showed CV values lower than the check value, indicating that they were more uniform in their leaf area. The results obtained in this study are in line with)32) , who found that treating wheat seeds with UV irradiation had significant effect towards reduce the germination percentage and the content of chlorophyll in seedlings. The heterogeneity obtained at some doses of UV–irradiation was induced by genetic mutation due to its oxidative role and forming free radicals affecting on flowering, sex expression and photosynthesis [33]. In this respect,)34) noticed that gamma irradiation caused an increase in the empty seeds percent in zucchini fruits if compared to the lower doses that produced fully developed seeds containing fully mature embryo. Meanwhile,)35) found from the technique of irradiating seeds or pollen grains by UV, X – rays or gamma rays produced stimulation of mono-chromosomal plants that reduces pollen vitality or kills pollen grains leading them to pollinate and fertilize the ovary, to be helps in generate fruits virginity.

In conclusion, the lower doses of UV irradiation is effective on some cucurbit genotypes for controlling the expression of female flowers. Meanwhile, the higher doses of UV irradiation is not recommended to be used in control-

ling sex expression of floral differentiation because they are leading to increase the development of male flowers. The exposure periods to 12 minutes gave significant increases in the floral differentiation of male flowers developed per plant, leading to decrease femaleness, as a consequence decrease fruits yield per plant. Thus, the lower doses is recommended in controlling sex expression of female flowers, as a consequence increasing fruits yield per plant.

Conflict of interest

The author declare that this manuscript was done in the absence of any commercial or financial relationships that could be conducted as a potential conflict of interest.

Ethical approval

This study does not indicate any human or animal testing or feeding on irradiated products.

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