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Effect Of Gamma Irradiation And Sodium Azide On Some Economic Traits In Tomato

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Abstract. The objectives of this investigation was to study the effect of the two mutagens gamma rays at three doses (2,4 and 6 K/rad) and sodium azide at three concentration (0,001, 0.002, and 0.003 ml/L) on the expressivity of the genes controlling economic traits on tomato hybrid named "madeer". Mutagenic treatments with 2,4 K/rad gamma rays and 0,001 ml/L sodium azide enhanced all studied tomato traits . On the other hand ,4 K/rad gamma rays was the best mutagenic treatments than the others , which caused increasing of tomato traits over control as fellow: plant height 27.09%; fruit number 79.91% fruit weight 45.77%; fruit yield/ plant 140.25%; chlorophyll a and b 80.28% and 40.93% respectively and carotenes 85.71% . However, the reverse is true for the two sodium azide concentrations 0.002 and 0.003 ml/L which they reduced the values of plant height, chlorophyll a,b, carotenes and caused full sterility for tomato plants. While, 6K/rad gamma rays revealed the same effects for studied tomato traits of that respective control. Concerning to SDS protein electrophoresis, 2,4 K/rad gamma rays treatments enhanced the tomato genome to active some gene as they expressed by the appearance of some new minor band, which its responsible to improvement studied tomato traits. While the opposite was true for 6 K/rad gamma rays and 0,001 ml/L sodium azide treatments, where less number of bands were appeared.

Introduction

Antoun (1980) indicated that treatments of two tomato varieties seeds with gamma rays and Ethylmethanesulphonate (E.M.S) resulted in an improvement of economical traits . In the same time, Abo-hegazi (1991) obtained an early flowering, higher yield, tolerance to salinity and earliness in plants after exposure to different mutagens. Saccarado *et al.* (1991) reported that different types of radiations and chemical mutagenic agents such as E.M.S. induced mutant lines which have been utilized as parents for production of F1 hybrids with best marker gene. Asmahan (1993) found that mutagenic treatment with sodium azide was more effective in improvement of yield component in maize hybrids than gamma irradiation and that these mutagenic treatment changed the number, intensity and/or density of SDS electrophoretic bands for grains protein than respective control. In the other hand,Wang-Cailian *et al.* (1993) found that the biological injuries of first mutagenic generation increased with increase of gamma irradiation doses or sodium azide concentrations and treatment with the low mutagenic doses improved plant growth in rice. Al-Ouadat and Razzouk (1994) and Chang Kum (1994) found that low gamma irradiation doses increased plant height, stimulating effects on earliness and increased total plant yield in tomato hybrids. However, El-Sayed *et al.*(1994)found that 10 Krad gamma rays increased plant height , yield , chlorophyll a and b and carotenoids in tomato hybrids. Deng-Hong *et al.* (1994) reported that nitrogen ion beam with the energy of 400 Mev/u improved agronomic traits in rice plant. Meanwhile ,induced mutants in tomato has early maturing, significant variability in fruit size, fruit yield and seeds per fuit were found in tomato cultivar treated with gamma rays and E.M.S. (Jayabalan and Rao 1994, Zeerak *et al.* 1994). Induced mutant obtained after wheat treated with gamma rays exhibited higher grains yields than the parental population (Al-Kobaisi *et al.* 1997 and Gautam *et al.*1998). Asmahan

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(2000) recorded that the highest values of hybrid vigor over the mid-parents for yield component were obtained after tomato mutagenic treatment with E.M.S. Rascio *et al* (2001) used sodium azide as a mutagenic trareatment for durum wheat and screened high yield component in M4 generation .Osama.(2002) reported that irradiated wheat hybrid with 10 Krad gamma rays enhanced the values of yield component.

Materials and methods

The tomato hybrid *lycopersicon esculentum*, Mill named:'" Madeer" was used in this investigation. Tomato hybrid seeds were treated with two mutagenic treatments, i.e: gamma irradiation as a physical mutagen and sodium azide as a chemical mutagen. Mutagenic treatment with gamma rays were conducted by irradiating tomato seeds with 2,4 and 6 Krad gamma rays with dose rate 1.36 rad/second from Cobalt 60 in Gamma Cell 220 at the National Center for Radiation Research and Technology, Nasr City, Cairo, Egypt.

On the other hand, mutagenic treatments with sodium azide (NaN3) were conducted by treatment of tomato seeds with three concentrations i.e: 0.001 ,0.002 and 0.003 M NaN3 in phosphate buffer solution at pH3. Tomato seeds mentioned before were soaked in a liter of water for six hours prior to soaking in 0.001,0.002, and 0.003 M/L sodium azide for two hours at 20°C. Then after, the treated seeds were followed immediately by thorough washing in running water for four hours. Untreated tomato seeds as well as those treated with either gamma rays or sodium azide were sown in Complete Randomized Block Design (CRBD) with three replications. Data were recorded on the following traits: plant height (cm).; fruit number/plant.; fruit weight (gm) and fruit yield/plant (gm) Chlorophyll a,b and carotenes content mg/om2 in untreated and treated tomato leaves were determined by the method of Comar and Zscheile (1942). Polyacrylamide gel electrophoresis (PAGE) of untreated and treated tomato seeds protein extracts were performed according to the method of Laemmli (1970) as modified by Studier (1973). Data were statistically analyzed according to SAS (1988). To test significance ofchanges in tomato traits the were tested against the least significant differences (L.S.D) at 5% and 1% levels of significance.

Results and Discussion

1-Yield-related traits:

The analysis of variance for studied tomato traits were presented in Tables 1 and 2. It is clear that the mutagenic treatments exhibited highly significant differences on the performance of all yield related traits.

From Table 3 and Fig 1 we found that overall mean of both mutagenic treatments , gamma rays

Table 1. Mean square of analysis of variance for plant height, Chlorophyll a,b and carotenes in the tomato hybrid treated with either gamma rays or sodium azide as well as its corresponding untreated ones (controls).

Source of variance (S.O.V)	Degree of freedom	plant height	Chlorophyll a	Cholorophyll b	carotenes
Treatments	6	1671.30**	34.90**	5.37**	2.02**
Replicates	2	8.14	0.53	0.72	1.16
Error	12	8.75	1.99	0.45	0.27
Total	20				

**Significant at 0.001 level.

Table 2. Mean square of analysis of variance for yield component in the tomato hybrid treated with either gamma rays or sodium azide as well as its corresponding untreated ones (controls).

Source of variance (S.O.V)	Degree of freedom	Fruit number	Fruit wight	Fruit yield /plant
Treatments	4	18.93**	189.93**	95264.17**
Replicates	2	4.27	3.47	2361.67
Error	8	0.933	50.88	6774.17
Total	14			

**Significant at 0.001 level.

Table 3. Mean of all studied trait for tomato hybrid treated wit either gamma rays or sodium azide as well as its correponding untreated ones (control).

Traits / Treatments		plant height (cm	Fruit number	Fruit Weight (mg)	Fruit Yield (gm)	Chlorophyll a (mg/Dm²)	Cholorphyll b (mg/Dm²)	Carotenoid (mg/Dm²)
Control		67.67	6.67	39.33	265.00	9.13	4.74	2.17
Gamma rays	2Krad	79.67	9.00	50.67	460.00	14.60	6.28	3.14
	4Krad	86.00	12.00	57.33	636.67	16.46	6.68	4.03
	6Krad	66.67	6.67	41.00	275.00	8.75	4.16	1.97
	Ovr all mean	77.45	9.22	49.67	457.22	13.27	5.71	3.05
Sodium Azied	0.001	68.00	11.33	54.00	615.00	13.71	6.90	2.92
	0.002	28.33	--	--	--	7.97	3.71	1.75
	0.003	26.67	--	--	--	9.03	4.22	2.04
	Over all mean	41.00	3.78	18.00	205.00	10.24	4.94	2.24
L.S.D. at 0.001 level		5.16	2.12	8.75	80.80q	3.25	1.50	0.95

Table 4. Phenotypic Correlation between fruit yield and Chlorophyll traits (Chlorophyll a,b, Carotenoid) in tomato hybrid.

Traits	Furit yield	Chlorophyll a	Chlorophyll b	Carotenoid
Fruit yield	---	0.917**	0.954**	0.887*
Chlorophyll a	0.917**	---	0.948**	0.980**
Cholorophyll b	0.954**	0.948**	---	0.889**

*Correlation is Significant at the 0.05 level.
**Correlation is Significant at the 0.01 level.

and sodium azide were: plant height 77.45 , 41.00 ; fruit number/plant 9.22, 3.78; fruit weight 49.67, 18.00 and for fruit yield/plant 457.22 , 205.00, respectively. However, the means in the respective control of above tomato traits were: plant height 67.67; fruit number /plant 6.67; fruit weight 39.33 and fruit yield/plant 265.00.

Concerning mutagenic treatments ,we found that 2 and 4 Krad gamma rays and 0.001 M/L sodium azide enhanced and increased all values of tomato yield traits, while 6 Krad gamma rays effect was similar to its respective controls.

On the other hand,0.002 and 0.003 M/L sodium azide caused a reduction of plant height value and caused a full sterility of all tomato plants.

The best mutagenic treatment was 4 Krad gamma rays which caused increas of tomato yield traits over its respective control as fellow: plant height 27.09%; fruit number/plant 79.91 Table 1; fruit weight 45.77%; fruit yield/plant 140.25%.

2- Physiological Parameters:

Table 1 showed that the two mutagenic treatments exhibited highly significant differences on the performance of chlorophyll a,b and carotenoid.

Overall means of after both mutagenic treatments, gamma rays and sodium azide were : chlorophyll a 13.27, 10.24; chlorophyll b 5.71, 4.94; carotenoid 3.05,2.24, respectively. Whereas, the means of these traits in their respective controls were: chlorophyll a 9.13, chlorophyll b 4.74 and carotenoid 2.17 (Table 3).

The best mutagenic doses which enhanced formation of chlorophyll a,b and carotenoid were 2,4 Krad gamma rays and 0.001 M/L sodium azide while the worest doses were 0.002 Krad gamma rays and 0.003 M/L sodium azide which reduced these traits when compaired to their respective controls.On the other hand,4 Krad gamma rays was the best mutagenic treatment which increased these traits over their respective controls as fellow: chlorophyll a 80.28%; chlorophyll b 40.93% and carotenoid 85.71% (Table.3).

3-Phenotypic correlation between fruit yield and chlorophyll traits:

There were highly significant positive correlations between fruit yield and chlorophyll a ; b and carotenoid and also between chlorophyll a , chlorophyll b and carotenoid. (Table 4). From the previous obvious results we concluded that 4Krad gamma rays was the

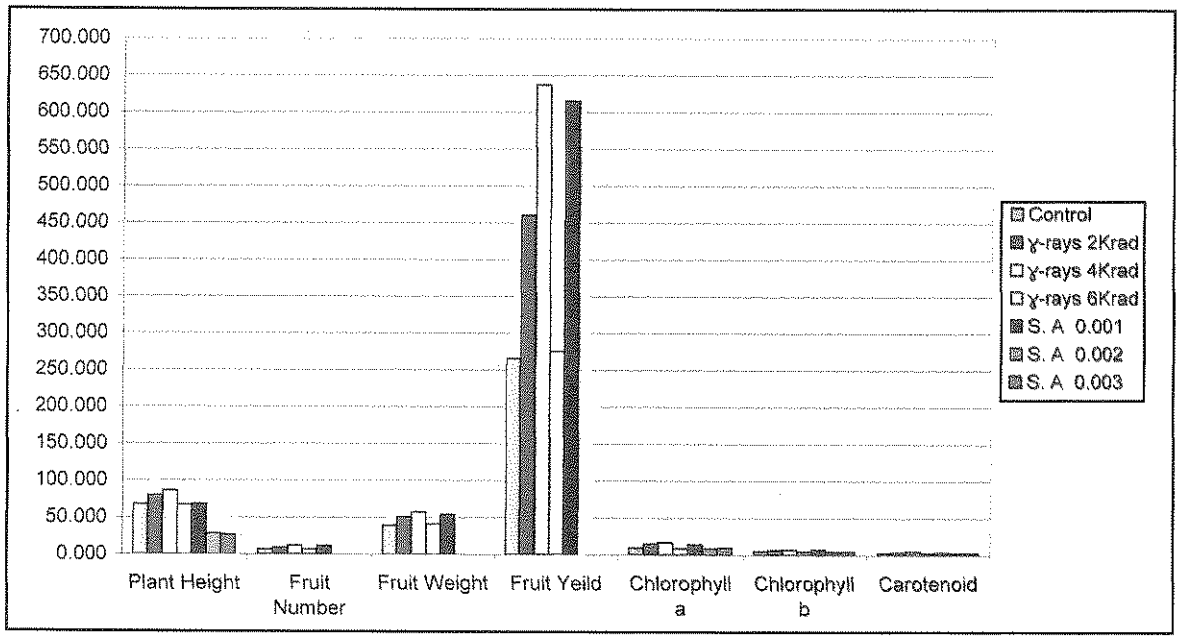
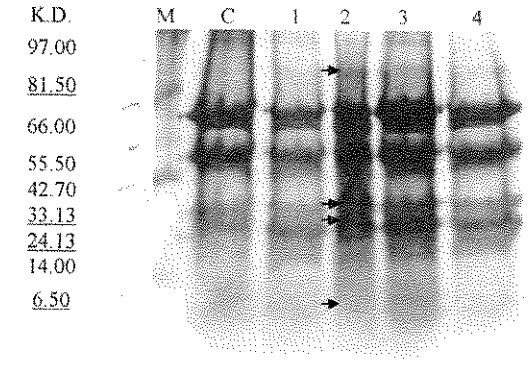


Fig 1. Effect of gamma rays and sodium azide mutagens on the seven studied traits for the tomato hybrid "Madeer".

best mutagenic treatment which improved chlorophyll parameter (i.e: chlorophyll a,b and carotenoid) which consequently increased all yield-related traits.



M= Marker
C= Control
1= 6 Krad gamma rays.
2= 4 Krad gamma rays.
3= 2 Krad gamma rays.
4= 0.001 M/L sodium azide.

Fig 2. SDS-PAGE of water soluble seeds protein of tomato hybrid "Madeer" treated with either gamma rays or sodium azide as well as their respective contols.

These results were almost in agreement with those of Antoun (1980), Saccardo *et al.*(1991); Asmahan (1993);Wang-Cailian *et al.* (1993); Chongkum(1994); El-Sayed *et al.* (1994); Al-Oudat and Razzouk (1994); Zeerak *et al.*(1994); Al-Kobaissi *et al.*(1997);Gautam *et. al.* (1998); Asmahan (2000); Rasico *et al.*(2001) and Osama (2002), who reported that the improvement of yield components and chlorophyll parameters in various plants such as tomato, maize, rice and wheat was induced after various mutagenic treatments such as E.M.S, sodium azide and gamma rays.

4-SDS-Protein electrophoresis:

From Fig 2 we found that the number , intensity and or density of SDS electrophoretic band for seeds protein generally varied after both mutagenic treatments, gamma rays and sodium azide. Whereas 2 and 4 Krad gamma rays increased the number, intensity and density of these bands, the reverse was true for the other two mutagenic treatments, i.e. 6 Krad gamma rays and 0.001M/L sodium azide. 4 Krad gamma rays releaved new minor bands at 81.50 and 6.50 KD and increased intensity and density of bands at 33.13 and 24.13 KD . which may be related to the improvement of the studied tomato traits.

The 4 Krad gamma rays treatment seemed to enhance the tomato genome and activate expression of some genes which resulted in the appearance of some new minor bands. These results are almost in agreement with those of Abdel-Salam (1991), Asmahan (1993), and Osama (2002) who found variations in number, intensity and or density of SDS electrophoretic bands of proteins from wheat and maize after gamma irradiation and sodium azide treatments.

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تأثير التشعيع الجامي وآزايد الصوديوم على بعض الصفات الاقتصادية في الطماطم

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تناول هذا البحث تحسين الصفات الو راثية لنبات الطماطم باستخدام المطفرالطبيعي أشعة جاما والطفر الكيماوي آزايد الصوديوم.

شملت الدراسة استخدام (٣) جرعات لأشعة جاما هي ٢,٤,٦ ك راد وكذلك (٣) تركيزات من آزايد الصوديوم وهي ,٠٠١ ، ,٠٠٢ ٠٠٣ملليلتر/ لتر وذلك على هجين الطماطم " reedaM " حيث عوملت بذور هذا الهجين بتلك المعاملات الطفرية وتم زراعة الجيل الطفري الأول في تجربة تصميم القطاعات الكاملة العشوائية في ثلاث مكررات وكانت النتائج كالآتي:

١. أدت المعاملات الطفرية بـ ٤,٢ ك راد بأشعة جاما و ٠٠١, ملليلتر/ لتر آزايد الصوديوم لتحسين كل الصفات السبع المدروسة في نبات الطماطم.

٢. كانت الجرعة ٤ ك راد لأشعة جاما أحسن المعاملات الطفرية حيث أدت لارتفاع قيم الصفات المدروسة عن النباتات غير المعاملة بالنسب التالية : -

طول النبات ٠٩ ,٢٧٪ ، عدد الثمار/ للنبات ٩١ ,٧٩ ٪ ، وزن الثمرة ٧٧ ,٤٥٪ ، محصول الثمار / للنبات ٢٥ ,١٤٠٪ ، كلورفيل ٢٨ ,٨٠ أ٪، كلورفيل ب ٩٣ ,٤٠ ٪ والكاروتينات ٧١ ,٨٥٪ .

٣. أظهرت الجرعة الإشعاعية ٦ ك راد تأثيرا على صفات الطماطم المدروسة مماثل لتلك الموجودة في النباتات الغير معاملة .

٤. أظهرا الجرعتان الطفريتان ٠٠٢ ,٠ ، ٠٠٣ ,٠ ملليلتر/ لتر آزايد الصوديوم تأثيرا سيئا على نباتات الطماطم حيث أدت لقصر طول النبات وانخفاض في قيم كلورفيل أ ، ب والكاروتينات وحدوث عقم تام لكل نباتات الطماطم.

٥. أظهرت حزم التفريد الكهربي لبروتين بذور الطماطم أن الجرعتان ٢،٤ ك راد لأشعة جاما أدت لظهور بعض الحزم الصغيرة والتي قد يكون لها بعض الصلة بالتحسين في صفات الطماطم المدروسة بينما كان العكس هو الصحيح بالنسبة للجرعة الإشعاعية ٦ ك راد والتركيز ٠٠١, ملليلتر / لتر آزايد الصوديوم .