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THE EFFECT OF ETHYL MATHANE SULPHONATE (EMS) ON GENETIC IMPROVEMENT ON TOMATO

Asmahan A. Mahmoud
National Center for Research and Radiation Technology, Atomic Energy Agency, Cairo, Egypt.

ABSTRACT

The present investigation was conducted to investigate the genetic effect of ethyl mathane sulphonate (EMS) on four tomato varieties. These varieties were Pritchared (1), Money Maker (2), No.10 (3) and Bison (4). Air-dried seeds of these varieties were treated with 0.10% EMS. Treated and untreated seeds of the four tomato varieties were individually sown and crossed according to half diallel program. EMS treatment induced slight improvement on plant height, yield components (fruit number, fruit weight and fruit yield), earliness of flowering and Vit. C content in all tomato varieties. Heterosis values over the mid parents and the better parent were recorded a highly improvement and increased for all studied traits in tomato hybrids after EMS treatment than their respective control. On the other hand, EMS treatment caused a reduction in inbreeding depression for all studied traits in tomato plants than their respective control. The highest values of hybrid vigor over the mid-parents were recorded after mutagenic treatment with EMS in hybrids: 1X4 (earliness of flowering –7.07%, fruit number 53.85% and Vit. C content 60.77%); 1X3 (fruit weight 43.26% and fruit yield 150.00%) and 2X3 (plant height 33.77%). On the other hand, The lowest values of inbreeding depression were observed after mutagenic treatment with EMS in hybrids: 2X3 (plant height 8.33%); 1X3 (fruit number 7.50% and fruit yield 9.99%); 1X4 (fruit weight 10.30%); 3X4 (Vit. C content 13.30%) and 1X2 (earliness of flowering –4.95%).

INTRODUCTION

Antoun (1980) indicated that the treatment of the seeds of two tomato varieties with gamma rays and EMS resulted an improvement of economical traits. In the same time, Abo-Hegazi (1991) obtained an early flowering, higher yield, tolerance to salinity and earliness after use of different mutagens in plant. Saccardo *et al.*(1991) reported that different types of radiation and chemical mutagenic agents such as E.M.S. induced mutant lines have been utilized as parentals for the production F1 hybrids with best marker gene. Dod *et al.*(1992)evaluated 66 F1 hybrids of tomato. They observed pronounced heterosis for yield/plant, fruit number /plant and plant height. Sherif and Hussein (1992) evaluated seven parents of tomato and the F1 hybrids among them. They observed the presence of heterosis values for most studied traits. Bora *s.* (1993) studied parents eight varieties of tomato and 19 F1 hybrids derived from them. They found that heterosis for yield over the better parent was significant in 11 crosses. Sidhu and Surjan Singh (1993) evaluated 55 different hybrids among 11 tomato varieties. They claimed that heterosis values ranged from 23.8% to 71.7%. Al-Oudat and Razzouk (1994) found that the low doses of gamma radiation increased plant height, stimulating effects on earliness and increased total yield per plant for tomato hybrids. Chongkum (1994) used radiation in plant breeding for better yield and disease resistance in tomato. Deng-Hong *et al.* (1994) reported that argon ion beam with the energy of 400 Me v/u improved agronomic traits in rice plant . EL-Sayed *et al.*(1994)found that irradiating seeds of tomato varieties and all expected crosses stimulated the fruit characters, however, they were still less than the better parent. Jayabalan and Rao (1994) induced mutants in tomato has early maturing. Significant variability in fruit size, fruits per plant and seeds per fruit were found in tomato cultivar treated with gamma rays and E.M.S. (Zeerak *et al*.1994). Suresh *et al.*(1995) evaluated seven tomato lines and 21 F1 hybrids among them. They observed greatest heterosis superior parents for average fruit weight (30.80%) fruit number (143.10%), early yield (41.60%) and total yield (72.20%). El –Sharkawy *et al.*(1997) found that F1 tomato hybrids significantly exceeded the mid parents for plant height, branches number/plant, fruit number /plant, fruit weight/plant and ascorbic acid content. They also found that all tomato studied traits exhibited significant inbreeding depression i.e. all F2 generation were decreased than their F1 hybrids for all studied traits.

MATERIALS AND METHODS

Four varieties of tomato *lycopersicon esculentum, Mill* named : Pritchard (1), Money Maker (2), No.10 (3) and Bison (4) were used in this investigation. Air-dried seeds of these varieties were treated with 0.10% Ethyl mathane sulphonate (E.M.S.) as a chemical mutagen. Seeds of varieties were soaked in E.M.S. aqueous solution at 0.10% for a period of 24 hrs. followed immediately by thorough washing in running water for 12 hours. Seeds of four tomato varieties as well as treated seeds (M1's) were individually sown and crossed according to half diallel mating design crossing program to obtain F1's, F2's for control crosses and M2's, M3's for mutagenic crosses. The experiments were conducted at the two growing seasons of 1998 and 1999 in the exp. Field at the National Center for Res. and Rad. Technol., Cairo, Egypt. The parental varieties and their crosses (F1's and F2's for control) as well as treated varieties (M1) and their crosses M2's and M3's for mutagenic treatment were sown in randomized complete block design experiment with three replications. Data were recorded on the following traits: days to 50% flowering (earliness of flowering) D. Fl., plant height (cm) P.H., fruit number/plant F.N., fruit weight (gm) F.W., fruit yield/plant F.Y. and vitamin c Vit c. content (mg/l00gm)according to Abdel Kader *et al.*(1968). Data were statistically analyzed according to SAS (1988). Heterosis values were determined as the percentage division of F1 over either the mid-parents(M.P.) or the better parent (B.P.) according to the following formula adopted by Bhatt (1971).

H(M.P.)%=(F1-M.P./M.P.)X 100.

H(B.P.)%=(F1-B.P./B.P.)X 100.

Inbreeding Depression (I.D.) was determined as the percentage decrease of the F2 generation below the F1 hybrids according to liang *et al*.(1972) as follows:

I.D.=(F1-F2/F1)×100

To test the significance of parental tomato traits mean and heterosis, the differences were tested against the lest significant differences (L.S.D.) at 5% level of significance.

RESULTS AND DISCUSSION

1- Growth Stimulation By Mutagenic Treatment in M1 Generation:

The results cleared that the variety (1) was the earliest in flowering, whereas variety (3) was the longest stem with the highest fruits number and the highest vit. C content. Meanwhile, variety (4) was the shortest stem with the highest fruit weight and fruit yield. Generally, days to 50% flowering were decreased for all varieties in M1 generation as a function of EMS treatment. Whereas, other tomato traits did not gain the same trend. Also, it could be observed that mutagenic treatment with E.M.S. caused a significant increased the height of plant for all varieties in M1 except for variety (3) which decreased by this treatment (Table 1). Yield component i.e:(fruit number, fruit weight and fruit yield) were significant increased by E.M.S. mutagenic treatment for all varieties in M1. Mean While, fruit yield reached the maximum value in variety (4) at M1. On the other hand, vit. C content in fruit was increased as a function of M.E.S mutagenic treatment in all varieties at M1 except for var. (1) which decreased. However, vit. C content reached the maximum vlue in var. (3) at M1 (Table 1). These reuslts are in agreement with those obtained by Abo-Hegazi (1991), Saccardo *et al.*(1991),Al-Oudat and Razzouk(1994), Deng-Hong (1994), Jayabalan and Zeerak *et al.*(1994).

2-Gene Expression For Heterosis After Mutagenic Treatment in M2 Generation:

Mutagenic treatment with E.M.S. increased the overall heterosis average for mid-parents and the better parent. The average heterosis over mid parents were: -4.21%, 26.64%, 33.76%, 35.11%, 86.14% and 39.32% for earliness of flowering, plant height, fruit number, fruit weight, fruit yield and vit. c content, respectively in M2 generation compared with –2.50%, 18.69%, 22.92%, 30.10%, 69.97%, 14.38% in F1 generation (Table 2). On the other hand, heterosis average over better parent were (-0.81%, -2.51%), (5.62%, 17.75%), (-2.67%, 5.91%), (1.22%, 7.12%), (33.79%, 47.95%) and (2.48%, 20.06%) in F1 and M2 generation for earliness of flowering, plant height, fruit number, fruit weight, fruit yield and vit.C content respectively (Table 3). Heterotic values of earliness of flowering at F1's control ranged from (-1.92% to –3.32%) and from (-0.98% to –2.86%) as compared with mid and better parents, respectively. In M2's E.M.S. treatment, heterotic values for the same trait ranged from (-1.48% to –7.07%) and from (-2.04% to –6.12%) as compared with mid and better parents, respectively (Table 2 and 3). Plant height heterotic vales ranged from (19.34% to 33.77%) and from (9.96% to 29.08%) as compared with mid and better parents respectively at M2 generation. However they ranged from (13.32% to 25.82%) and from (2.29%

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to 9.09%) as compared with mid and better parents at F1. Yield component i.e:(F.N., F.W. and F.Y.) heterotic values at F1 were ranged from (15.38% to 33.51%), (20.55% to 37.93%) and (51.30% to 104.76%) over mid parents and they ranged from (-20.27% to 14.29%), (-11.36% to 10.00%) and (2.89% to 79.17%) over better parent. On the other hand, heterotic values F.N., F.W. and F.Y. were ranged from (10.75% to 53.85%), (21.21% to 43.26%) and (46.19% to 150.00%) over mid parents, while they ranged from (0.50% to 8.97%), (-3.33% to 14.67%) and (16.43% to 118.75%) over better parent at M2. Heterosis values over mid parents for vit. C content ranged from (10.29% to16.71%) at F1, while it ranged from (23.02% to 60.77%) at M2. However, heterosis values for the same trait over better parent were ranged from (-7.79% to 10.00%) (11.11% to 30.43%) at F1 and M2, respectively. From previous results we concluded that mutagenic treatment with E.M.S. caused a negative increased of heterosis values for earliness of flowering and a positive increased of heterosis values for other tomato traits than their respective controls. The highest values of hybrid vigor were recorded at M2 generation in hybrids: 1X3 (fruit weight 43.26% and fruit yield 150%), 1X4 (earliness of flowering–7.07%, fruit number 53.85% and vit. C content 60.77%) and 2X3 (plant height 33.77%). The above results are relatively in agreement with those reported by Abo Hegazi(1991), Saccardo *et al.*(1991), Al-Oudat and Razzouk(1994), Jayabalan and Rao (1994) and El-Sharkawy *et al.*(1997).

3- Gene Expression For Inbreeding Depression After Mutagenic Treatment in M3 Generation:

Mutagenic treatment with E.M.S. decreased the inbreeding depression (I.D.) over all average for all tomato traits in M3 generation. Whereas I.D. average were (-4.65%, -3.41%), (13.73%, 11.11%), (18.68%, 13.29%), (21.19%, 12.46%), (34.05%, 20.81%) and (19.17%, 15.80%) at F2's control and M3's E.M.S. treatment for earliness of flowering, P.H., F.N., F.W., F.Y. and vit. C respectively. Earliness of flowering I.D. ranged from (-5.10% to –3.92%) and from (-2.20% to –4.95%) in F2 and M3 generation, respectively. While I.D. for plant height were ranged from (12.26% to 15.00%) at F2 and from (8.33% to 13.41%) at M3 (Table 4). Yield component i.e. (F.N., F.W. and F.Y.) I.D. were ranged from (15.25% to 25.29%), (16.47% to 28.01%) and (29.87% to 40.42%) at F2, However they ranged from (7.50% to 17.65%), (10.30% to 14.44%) and (9.99% to 27.27%) at M3. On the other hand, vit. C content I.D. ranged from (15.85% to 21.88%), (13.30% to 17.15%) at F2 and M3 generation respectively. The lowest values of I.D. were recorded at M3 generation in hybrids: 1X2 (earliness of flowering –4.95%), 2X3 (plant height 8.33%), 1X3 (fruit number 7.50% and fruit yield 9.99%), 1X4 (fruit weight 10.30%) and 3X4 (vit. C content 13.30%). Regarding to the previous results, we concluded that EMS mutagenic treatment caused a reduction of inbreeding depression than their respective control. Inbreeding depression caused by random genetic drift, played a small role in most traits in tomato. This result was in agreement with that of El-Sharkowy *et al.*(1997). Mutagenic treatment have reduced this random genetic drift, which played an important role in most tomato traits, leading to a

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reduction in the inbreeding depression of these traits. These results were in agreement with those obtained by many authors among them Abo Hegazi (1991). In conclusion, the result of this investigation indicated the presence of heterosis. The possibilities of using of EMS as a chemical mutagenic and selection promise genotypes to obtain new inbred lines. These lines could be crossed to obtain a highly hybrid vigor and lowly an in breeding depression.

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تأثير ايثيل ميثان سلفونيت على التحسين الوراثى فى الطماطم

أسمهان أحمد محمود
المركز القومي لبحوث و تكنولوجيا الأشعاع-هئية الطاقة الذرية-مدينة نصر-مصر.

- تناول هذا البحث تحسين الصفات الوراثية لنبات الطماطم باستخدام المطفر الكيماوي ايثيل ميثان سلفونيت (EMS)و التهجينات النصف دائرية.
- شملت الدراسة ٤ أضناف من الطماطم هى:-

(1)Pritchard, (2)Money Maker, (3)No.10, (4)Bison.

- عوملت بذور الـ٤ أصناف للطماطم بالـ EMS بتركيز ١٠و% و تم عمل التهجينات النصف دائرية بين تلك الأصناف داخل كل معاملة على حدة و كانت النتائج كالآتى :

1- أدت المعاملة الطفرية لزيادة معنوية في أغلب الصفات المدروسة للأربعة أصناف في الجيل الطفري الأول(M1).

2- أرتفعت قيمة قوة الهجين لجميع الصفات المدروسة نتيجة المعاملة الطفرية فقد بلغ أعلي قيمة للتأثير الهجينى عن متوسط الأبوين في صفات طول النبات و محصول الثمار و فيتامين C للهجن في الجيل الطفرى الثانى (M2) على النحو التالى :٧٧و٣٣% و ١٥٠% و ٧٧و٦٠% في حين كانت أعلي قوة هجين في هجن المقارنة (F1) هي ٨٢و٢٥% و ٧٦و١٠٤% و ٧١و١٦% للصفات السابقة علي الترتيب .

3- أدت المعاملة الطفرية لتقليل نسبة الأنخفاض نتيجة التربية الداخلية للهجن في الجيل الطفرى الثالث (M3) عنها في الجيل الثاني لهجن المقارنة (F2)حيث بلغت اقل قيمة للأنخفاض نتيجة التربية الداخلية لمحصول الثمار ٩٩و٩% في المعاملة الطفرية بينما كانت ٨٧و٢٩% في المقارنة.

٤- اعطت الهجن (4 ×1) و (3 ×1) و (3 ×2) في الاجيال الطفرية (M2, M3) اعلا النتائج في قوة الهجين و اقل نسبة انخفاض نتيجة التربية الداخلية في معظم الصفات المدروسة.

و يمكن ان نشير الى أن هذه الدراسة أوضحت بأنه بأستخدام المطفر الكيماوى EMS و اجراء برنامج أنتخابى لأنتخاب نباتات ممتازة و ذلك للاستفادة منها في انتاج سلالات يمكن استخدامها في الحصول على هجن تتميز بمعدلات عالية لقوة الهجين كما تتميز بأقل نسبة انخفاض نتيجة للتربية الداخلي

Table (1) : Means of all studied traits for the four parental tomato varieties treated with E.M.S. as well as their corresponding untreated ones (control).

Varieties	Generations	Days to 50% Flowering D.Fl.	Plant Height (CM) P.H.	Fruit Number F.N.	Fruit Weight (gm) F.W.	Fruit Yield (gm) F.Y.	Vit.C content (mg/loogm) Vit. C
Pritchard (1)	C	100	99.50	5.60	66.00	360.00	8.00
	M1	98	106.20	6.50	75.00	480.00	7.16
Mony Maker (2)	C	106	110.00	13.50	47.00	640.00	10.00
	M1	103	116.70	15.10	55.00	830.00	11.25
No. 10 (3)	C	105	131.00	18.50	25.50	480.00	12.58
	M1	104	125.50	19.90	32.50	640.00	13.75
Bison (4)	C	102	82.00	14.00	80.00	1108.00	9.17
	M1	100	95.00	15.60	90.00	1400.00	11.50
Overall mean (control)		103.25	105.63	12.90	54.63	647.00	9.94
Overall mean (M1 generation)		101.25	110.85	14.28	63.13	837.50	10.92
L.S.D. at 5%		1.39	5.43	1.09	1.77	44.82	1.04

C: control M1: frist mutagenic generation.

Table (2) : Gene expression for heterosis of the studied traits at M2 over mid parents (as percentage) in six hybrids between four parental tomato varieties treated with E.M.S. as well as their corresponding untreated ones in F1 (control).

Crosses	Days to 50% Flowering D.Fl.		Plant Height P.H.		Fruit Number F.N.		Fruit Weight F.W.		Fruit Yield F.Y.		Vitamin C content Vit.C	
	F1	M2	F1	M2	F1	M2	F1	M2	F1	M2	F1	M2
(1×2)	-1.94	-4.48	13.32	19.34	33.51	48.15	23.89	32.31	78.00	99.39	16.67	35.72
(1×3)	-2.44	-2.97	18.44	26.03	22.41	51.52	27.87	43.26	104.76	150.00	12.73	52.96
(1×4)	-2.97	-7.07	15.70	27.98	32.65	53.85	20.55	21.21	55.31	80.85	16.71	60.77
(2×3)	-3.32	-4.35	13.86	33.77	17.19	20.00	37.93	39.43	60.71	63.95	15.15	32.00
(2×4)	-1.92	-1.48	25.00	27.54	16.36	10.75	33.86	32.41	51.03	46.19	14.70	23.02
(3×4)	-2.42	-4.90	25.82	25.17	15.38	18.31	36.49	42.04	70.03	76.47	10.29	31.43
Overall heterosis average	-2.50	-4.21	18.69	26.64	22.92	33.76	30.10	35.11	69.97	86.14	14.38	39.32
L.S.D at 5%	-2.21	-2.91	8.86	11.66	1.79	2.35	5.92	7.79	44.48	54.99	1.36	1.79

Table (3) : Gene expression for heterosis of the studied traits at M2 over better parent (as percentage) in six hybrids between four parental tomato varieties treated with E.M.S. as well as their corresponding untreated ones in F1 (control).

Crosses	Days to 50% Flowering D.Fl.		Plant Height P.H.		Fruit Number F.N.		Fruit Weight F.W.		Fruit Yield F.Y.		Vitamin C content vit. C	
	F1	M2	F1	M2	F1	M2	F1	M2	F1	M2	F1	M2
(1×2)	1.00	-2.04	7.90	13.97	-5.55	5.96	6.06	14.67	39.06	57.35	5.00	11.11
(1×3)	0.00	0.00	4.20	16.33	-20.27	0.50	-11.36	2.67	79.17	118.75	-7.79	16.36
(1×4)	-2.00	-6.12	5.53	21.47	-7.14	8.97	10.00	11.11	2.89	21.43	8.94	30.43
(2×3)	-2.86	-3.88	4.73	29.08	1.35	5.53	6.38	10.91	40.63	45.18	3.34	20.00
(2×4)	0.00	0.00	9.09	15.68	14.29	8.97	6.25	6.67	19.13	16.43	10.00	21.74
(3×4)	-0.98	-3.00	2.29	9.96	1.35	5.53	-10.00	-3.33	21.84	28.57	-4.61	20.73
Over all heterosis average	-0.81	-2.51	5.62	17.75	-2.67	5.91	1.22	7.12	33.79	47.95	2.48	20.06
L.S. Dat 5%	-2.21	-2.91	8.86	11.66	1.79	2.35	5.92	7.79	44.48	54.99	1.36	1.79

Table (4): Inbreeding depression (as percentage) for the traits characters at M3 in six hybrids between four tomato varieties treated with E.M.S as well as their corresponding untreated ones in F2 (control).

Crosses	Days to 50% flowering D.Fl.		Plant Height P.H.		Fruit Number F.N.		Fruit Weight F.W.		Fruit Yield F.Y.		Vitamin C Content vit. C	
	F2	M3	F2	M3	F2	M3	F2	M3	F2	M3	F2	M3
(1×2)	-5.00	-4.95	13.64	10.38	25.49	15.63	20.71	13.92	40.42	24.81	16.67	15.85
(1×3)	-5.00	-2.04	14.29	11.64	15.25	7.50	28.01	12.34	33.58	9.99	20.80	16.35
(1×4)	-5.10	-4.35	13.81	10.70	19.23	15.15	18.18	10.30	33.51	26.13	21.14	17.15
(2×3)	-3.92	-2.02	12.26	8.33	17.33	14.29	25.00	14.44	35.42	17.78	15.85	14.40
(2×4)	-3.92	-3.00	15.00	12.22	18.75	17.65	16.47	11.98	29.87	27.27	18.67	13.44
(3×4)	-4.95	-4.12	13.36	13.41	16.00	9.52	18.75	11.78	31.47	18.88	21.88	13.30
Inbreeding depression overall average.	-4.65	-3.41	13.73	11.11	18.68	13.29	21.19	12.46	34.05	20.81	19.17	15.08