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Effects of Chemical Mutagens on the Physio-Chemical Traits of Tomato (*Lycopersicon esculentum*)

L Tripathy[1], S Srichandan[2], S K Dash[3] J Bhuyan [2] and T R Sahoo[2]

College of Horticulture, Chipilima,
Odisha University of Agriculture and Technology, Bhubaneswar(Odisha)

ABSTRACT

A field experiment was conducted at the Horticultural Research station, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha during *Rabi* 2017 and 2018 seasons. Five hundred seeds of variety Utkal Kumari (BT 10) were taken and subjected to single and combined mutagenic treatment as per the specification. The experiment was laid down in Randomised Block Design (RBD) with three replications. Leaf area (dm^2/plant), total dry matter and chlorophyll content were measured at 30, 60 and 75 days after transplanting(DAT). NAR (Net assimilation rate) and CGR (Crop growth rate) were also calculated at 30-40 DAT and 50-60 DAT. All the treatments showed increase in yield over control and buffer except in treatment Sodium Azide (SA) 0.06% which indicated that the mutagens had positive effect on the plant for increasing yield. The increase in yield depends on leaf area or photosynthesizing tissues, total respiring tissues or total biomass, photosynthetic efficiency as reflected by chlorophyll content, Net assimilation rate (NAR) and crop growth rate (CGR). Ethyl methane sulphate (EMS) at 0.6% concentration had shown maximum increase in yield which was attributed to maximum leaf area (55.19 dm^2/plant), maximum total dry matter (19.44g/plant) and maximum crop growth rate ($0.347 g.m^{-2}.day^{-1}$). The chlorophyll content and NAR (Net assimilation rate) were also significantly high for this treatment.

Key Words: Assimilation rate, Crop Growth rate, Mutagenic treatment, Yield. Tomato

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) one of the important members of the solanaceae family is widely grown crop throughout the world. (Aoun *et al,* 2013; Sharma *et al* ,2016) Genetic manipulation through gene pyramiding is often met with difficulty and ultimately when succeeds a new genotype is born with change in many other characters. Mutation breeding is one of the major technique to develop stress resistant plants, its advantages is that mutants with multiple traits can be identified. The chances of survival of mutant varieties are much higher under rapid fluctuating climatic conditions. The creation of genetic variability by physical and chemical mutagens presents the plant breeder a greater opportunity of selecting beneficial mutants from mutant population. The discovery of chemical mutagens during the Second World War was another milestone in the history of induced mutation. Since then, many chemicals have been screened and found to induce mutations. The purpose of induced mutations is to enhance the mutation frequency rate in order to select appropriate variants for plant breeding. The mutagen treatment breaks the nuclear DNA and during the process of DNA repairs mechanism; new mutations are in-duced randomly which are heritable. The changes can occur in cytoplasmic organelles and results in chromosomal or genomic mutations and that enable plant breeders to select useful mutants such as flower color, flower

Corresponding Author's Email:jhuni.chutki@gmail.com

[1] College of Horticulture, Chipilima, OUAT

[2]Krishi Vigyan Kendra, OUAT

[3] College of Agriculture, OUAT, Bhubaneswar

Table 1. Details of mutagenic treatments.

Treatment	Mutagenic Treatment (hr.)	No. of Treatment
T_1= EMS (0.2%)	8	(I)
T_2= EMS (0.4%)	8	(I)
T_3= EMS (0.6%)	8	(I)
T_4= MH (0.02%)	8	(I)
T_5= MH (0.04%)	8	(I)
T_6= MH (0.06%)	8	(I)
T_7= SA (0.02%)	8	(I)
T_8= SA (0.04%)	8	(I)
T_9= SA (0.06%)	8	(I)
T_{10}= EMS (0.4%) + SA (0.04%)	4+4	(I),(II)
T_{11}= SA (0.04%)+ EMS (0.4%)	4+4	(I),(II)
T_{12}= EMS (0.4%)+ MH (0.04%)	4+4	(I),(II)
T_{13}= MH (0.04%)+ EMS (0.4%)	4+4	(I),(II)
T_{14}= Phosphate Buffer pH 3	8	(I)
T_{15}= Control	8	(I)

SA= Sodium azide, EMS= Ethyl Methane Sulphate and MH= Maleic hydrazide

shape, disease resistance and early flowering types. A specific advantage of mutation induction is the possibility of obtain-ing unselected genetic variation, improvement of vegetatively propagated plants when one or few characters of an outstanding cultivar are to be modified. Keeping these things in view, the present study was conceptualised with an objective to know the effect of chemical mutagens alone and in combination on the Physio chemical traits attributing to yield in tomato.

MATERIALS AND METHODS

The experiment was taken up at Horticultural Research station, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha during *Rabi* season of the year 2017 and 2018. The variety selected for this experiment was Utkal Kumari (BT 10). For each treatment 500 healthy seeds were soaked in distilled water for 8 hr at room temperature (15^o to 28^{o}C). The soaked seeds wrapped in blotting paper for complete drying were subjected to single and combined mutagenic treatment as per the specifications depicted in the Table1.

In combined mutagenic treatment, the materials were treated by the first chemical followed by thorough washing and again treated with the second chemical (Table1). There were two controls, one treated with Phosphate Buffer Solution at pH-3 and the other with distilled water. The mutagenic treatments were given in closed petri dishes with 50 ml. solution in each. The treatments were carried out under controlled temperature (20+1^{o}C) in B.O.D. incubator. The seed samples after treatments were thoroughly washed in running tap water for 1-2 min and seeded in the nursery bed.

Seedlings of the fifteen treatments were transplanted following Randomised Block Design (RBD) with three replications of plot size of 36.5 sq.m. A spacing of 60 cm plant to plant and 75cm row to row was given which accommodated 50 plants in total in a plot. The fertilizer dose was 100 kg N, 60 kg P and 60 K kg/ha followed by scheduled cultural management practices and plant protection

Table 2. Total yield of the tomato pooled over two years.

Sr. No.	Treatment	Yield per plant (Kg)	Percentage increase in yield over control		Average (%)
			Buffer	Control	
T1.	EMS 0.2%	1.00	69.49	51.52	60.51
T2.	EMS 0.4%	1.03	74.58	56.06	65.32
T3.	EMS 0.6%	1.28	116.95	93.94	105.45
T4.	MH 0.02%	0.93	57.63	40.91	49.27
T5.	MH 0.04%	0.97	64.41	46.97	55.69
T6.	MH 0.06%	0.92	55.93	39.39	47.66
T7.	SA 0.02%	0.82	38.98	24.24	31.61
T8.	SA 0.04%	0.73	23.73	10.61	17.17
T9.	SA 0.06%	0.47	-20.34	-28.79	-24.57
T10.	EMS 0.4%+SA 0.04%	0.64	8.47	-3.03	2.72
T11.	SA 0.04%+EMS 0.4%	0.65	10.17	-1.52	4.33
T12.	EMS 0.4% +MH 0.04%	0.90	52.54	36.36	44.45
T13.	MH 0.04% +EMS 0.4%	0.85	44.07	28.79	36.43

Buffer=0.59Kg/Plant Control=0.66Kg/Plant

measures taken.

Leaf area (dm^2/plant) was measured in Systronics leaf area meter at 30, 60 and 75 days of transplanting. NAR (net assimilation rate) and CGR (Crop growth rate) was also calculated as per this formula:

$$NAR = \frac{W_2P - W_1P}{T_2 - T_1} \times \frac{\ln A_2 - \ln A_1}{A_2 - A_1} \ g.cm^{-2}.day^{-1}$$

Where, w= dry weight, P= plant, T= time and A=area

$$CGR = \frac{\ln W_2P - \ln W_1P}{T_2 - T_1} \ g.m^{-2}.day^{-1}$$

Where w=dry weight, P=Plant and T=time (Dash *et al*., 1997)

NAR and CGR were calculated at 30, 45 and 60d of transplanting. Total dry matter of the whole plant was measured after oven drying at 60 °C for 48 hr at 30, 60 and 75d of transplanting. Total chlorophyll content of leaf was estimated by acetone extraction method (Arnon, 1949) at 30, 60 and 75d of transplanting. Total yield of the plant was also recorded. The data was collected and pooled over for two seasons and put to statistical analysis as per SPSS software packages.

RESULTS AND DISCUSSION

A careful analysis of the yield data(Table 2) revealed that all the treatments showed increase in yield over the buffer and control except in treatment SA 0.06% (Average percentage increase in yield over control= -24.57). The percentage increase in yield of treatments over control and buffer is represented in Table2. Treatment EMS 0.6% has recorded the maximum average percentage of increase in yield over control and buffer (105.45) followed by EMS 0.2%(60.51) and EMS 0.4%(65.32).

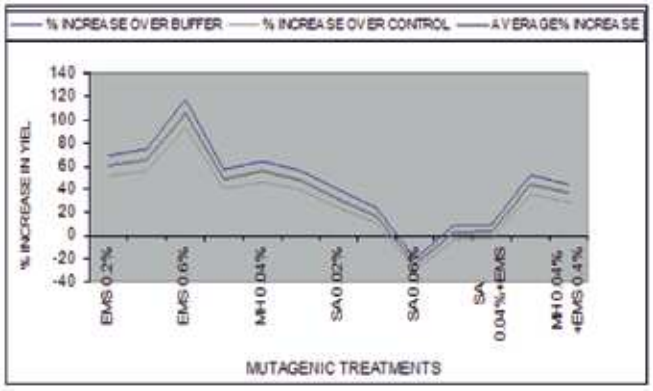
The increase in yield depends on leaf area or photosynthesizing tissues, total respiring tissues or total biomass, photosynthetic efficiency as reflected by chlorophyll content, Net assimilation rate (NAR) and crop growth rate (CGR) as presented in Table 3. All the characters exhibited significant difference among themselves.

It was observed that EMS at 0.6% concentration

Table 3. Depicting the physiochemical traits pooled over two years after treatment with chemical mutagens.

Treatment	Leaf Area (dm^2/plant)				Total dry matter (g/plant)				Chlorophyll content (mg/g)				NAR ($g.cm^{-2}.day^{-1}$)			CGR ($g.m^{-2}.day^{-1}$)		
	30d	45d	60d	Av.	30 d	45 d	60 d	Av.	30d	45d	60 d	Av.	30-40 d	50-60 d	Av.	30-40 d	50-60 d	Av
T1.	17.30	68.49	76.39	54.06	8.45	16.68	20.05	15.72	1.79	1.34	1.33	1.48	0.063	0.160	0.089	0.275	0.156	0.216
T2.	15.60	71.28	76.95	54.61	12.45	18.72	21.46	17.54	1.89	2.42	2.94	2.42	0.088	0.078	0.083	0.269	0.175	0.222
T3.	36.20	59.43	69.94	55.19	14.24	21.52	22.66	19.47	2.80	2.01	1.96	2.26	0.073	0.106	0.090	0.326	0.367	0.347
T4.	32.90	56.54	58.99	49.48	6.78	13.02	18.80	12.87	0.47	2.67	1.86	1.67	0.081	0.072	0.077	0.265	0.094	0.180
T5.	24.30	58.61	61.18	48.03	9.37	14.52	16.73	13.54	1.60	2.79	2.85	2.41	0.137	0.023	0.080	0.253	0.079	0.166
T6.	30.15	47.52	59.80	45.82	8.74	14.52	16.43	13.23	1.84	1.72	1.77	1.78	0.106	0.026	0.066	0.254	0.124	0.189
T7.	24.67	51.13	57.07	44.40	8.34	13.40	16.93	12.89	1.54	1.43	1.44	1.47	0.064	0.057	0.061	0.213	0.137	0.175
T8.	26.60	47.22	52.10	41.97	7.22	11.12	15.73	11.36	1.89	0.24	1.68	1.27	0.047	0.064	0.056	0.216	0.347	0.282
T9.	30.20	45.71	49.57	41.82	8.11	12.32	14.68	11.70	1.91	0.75	1.54	1.40	0.049	0.027	0.038	0.286	0.052	0.129
T10.	22.60	55.26	59.23	45.70	8.35	13.36	15.62	12.44	1.84	0.99	1.07	1.30	0.069	0.045	0.057	0.234	0.184	0.209
T11.	24.50	34.09	43.35	33.98	7.20	12.60	18.96	12.92	1.81	0.52	1.09	1.14	0.064	0.042	0.053	0.219	0.142	0.181
T12.	48.90	55.84	57.86	54.20	8.61	13.18	20.04	13.94	1.89	2.84	2.97	2.57	0.086	0.099	0.093	0.280	0.419	0.350
T13.	37.90	48.07	54.22	46.66	9.48	16.10	17.78	14.45	2.06	1.10	1.99	1.72	0.066	0.108	0.087	0.204	0.409	0.307
Buffer	11.60	29.38	34.98	25.32	10.05	14.52	19.84	14.80	1.97	1.51	1.82	1.77	0.079	0.016	0.057	0.184	0.312	0.248
Control	10.89	29.30	35.01	25.07	10.00	14.22	19.80	14.67	1.90	1.53	1.92	1.78	0.035	0.080	0.058	0.237	0.233	0.235
Mean	26.29	50.53	56.44	44.42	9.16	14.65	18.37	14.06	1.81	1.59	1.88	1.76	0.074	0.067	0.070	0.235	0.215	0.225
SE(M)	0.364	0.277	0.407	0.376	0.022	0.015	0.019	0.025	0.035	0.117	0.033	0.029	0.002	0.002	0.001	0.004	0.002	0.002
CD	1.052	0.801	1.175	1.087	0.062	0.043	0.054	0.073	0.102	0.338	0.097	0.083	0.007	0.006	0.004	0.012	0.006	0.005

Fig 1: The percentage increase in yield of tomato pooled over two years over buffer and control



Buffer=0.59Kg/Plant Control=0.66Kg/Plant

had shown maximum increase in yield, was due to maximum leaf area (55.19dm^2/plant), maximum total dry matter (19.44g/plant) maximum crop growth rate (0.347 g.m^{-2}.day^{-1}). The chlorophyll content and NAR (Net assimilation rate) were also significantly high for this treatment. Similar trend of growth attributes resulting maximum yield in tomato was also observed by Jois *et al* (2016) in case of pranic treatment.Treatments, which exhibited minimum yield was mutagen treatment with SA 0.06%. This treatment also recorded minimum NAR (0.038 g.cm^{-2}.day^{-1}). These two observations suggest that all these contribute to increase in yield, which corroborates the finding of Akhtar 2014.

It was also observed that the mutagenic treatments have influenced the leaf area. EMS has influenced the leaf area considerably in all the concentration (0.2%, 0.4% & 0.6%) alone or in combination at 0.4%EMS+0.04%MH. The results were found to be at par as a rule at different time interval, leaf area has shown its growth indicating the increase of photosynthesizing tissue. Similar kind of results was also observed by Adeosun *et al* (2020) where SA at 0.1 % and 0.3 % concentration had the best expression of morphology of different tomato varieties.

Total dry matter was also found to have increased over time and only EMS of 0.2%,0.4% and 0.6% alone have shown increase as against buffer and control except MH 0.04%+EMS 0.4% .Growth promoting effects of mutagens when applied at low doses have earlier been recorded in lentil (Amin *et al*, 2015) and in faba bean (Laskar and Khan, 2014)

The chlorophyll content has shown different trends for different treatments. EMS 0.2%, MH 0.06%, SA 0.04%, SA 0.06%, EMS 0.4%+ SA 0.04%, SA 0.04%+EMS 0.4% and MH 0.04% +EMS 0.4% initially had higher chlorophyll content but later it has decreased. On an average it is observed that EMS 0.4%, EMS 0.6%, MH 0.04% and EMS 0.4%+ MH 0.04% has shown highest chlorophyll content and are at par with each other. The results were similar in findings of Jitendra *et al* (2012) in Safflower where content of chlorophyll increased with decrease in intensity of mutagens.

NAR showed decreasing trend over time for treatments EMS 0.4%, MH 0.02%, MH 0.06%,SA 0.02%,SA 0.06%,EMS 0.4%+SA 0.04% and SA 0.04%+EMS 0.4%. But on an average NAR has increased as over control And Buffer. The maximum NAR was seen in combined treatment of EMS 0.4%+ MH 0.04%.

The CGR was recorded to have decreased over time for all the treatments which may be due to the fact that during and after fruiting the crop growth rate decreases as the photosynthates have diverted for fruiting. Maximum CGR was recorded in EMS 0.6% which is also the highest yielder and is at par with EMS 0.4% + MH 0.04% with respect to Crop growth rate.The EMS treatment in Tomato turned to be positive mutagen and it helped in speeding the growth rate and overall plant size(Ahmed et al.,2017).

CONCLUSION

All the treatments showed increase in yield over control and buffer except in treatment SA 0.06% which indicates that the mutagens had positive effect on the plant for increasing yield. The increase in yield depends on leaf area or photosynthesizing tissues, total respiring tissues or total biomass, photosynthetic efficiency as reflected by chlorophyll

content, Net assimilation rate (NAR) and crop growth rate (CGR). EMS at 0.6% concentration had shown maximum increase in yield, was due to maximum leaf area (55.19dm^2/plant), maximum total dry matter (19.44g/plant) maximum crop growth rate (0.347 g.m^{-2}.day^{-1}). The chlorophyll content and NAR (Net assimilation rate) were also significantly high for this treatment.

REFERENCES

Adeosun C A , Elem K A and Eze C D (2020). Mutagenic effects of sodium azide on the survival and morphological characters of tomato varieties. *Nigerian J Biotech* **37**(1) : 55-62

Ahmed MA, Chakraborty N, Tabana Y, Daham S, Ismail S I, Mohamed R, Yunus M and Sandai D(2017). The effect of physical and chemical mutagen on tomato plant. *Adv Biological Res* **11**(2):64-69.

Akhtar N(2014).Effect of physical and chemical mutagens on morphological behaviour of tomato cv RIO GRANDE under heat stress condition. *Pl Breed Seed Sci* **70**:69-79.

Amin R, Laskar R A, and Khan S (2015). Assessment of genetic response and character association for yield and yield components in Lentil population developed through chemical mutagenesis. *Cogent Food Agri* **1**: 1000715

Aoun A B, Lechiheb B and Benyahya L (2013). Evaluation of fruit quality traits of traditional varieties of tomato grown in Tunisia. *African J Food Sci* **7**(10): 350-354.

Jitendra K P, Preeti S, Ram S Yand Ram G (2012). Chlorophyll Fluroscence spectra as an indicatorof X ray + E MS induced phytotoxicity in safflower. *Hindwai Publishng Corporation Spectroscopy: An Int J* **27**(4):206-213.

Jois S N, Roohie K and Souza L D (2016). Physico –chemical qualities of tomato fruits as influenced by pranic treatments –an ancient technique for enhanced crop development. *Indian J Sci and Technol* **9** (46): 1-6.

Laskar R A, and Khan S (2014). Mutagenic effects of MH and MMS on induction of variability in broad bean. *Ann Res Rev Biol* **4**(7):1129-1140.

Sharma P K, Choudhary M K, Shekhawat B S and Prajapati K A (2016). Socio-economic Status and Constraints Faced by Tomato Growers in Kheda District. *J Krishi Vigyan* **5** (1): 114-116.

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