

Studies on Effect of EMS (Ethyl Methanesulphonate) on Papaya (*Carica papaya* L) Seeds under *in-vitro* Culture

**Yogesh Prasad Rajbhar, Sahab Lal, Mahesh Kumar,
Gopal Singh, Anil Kumar and Syed Sami Ullah**

*Department of Horticulture, Sardar Vallabhbhai Patel University of
Agriculture & Technology, Meerut-250110*

Abstract

The present experiment was carried out at Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (Uttar Pradesh) under two way Factorial experiments with three replications during 2011-12. Four varieties- Pusa Dwarf, Pant papaya 1, Pusa Giant and Washington were taken. The maximum seed germination (64.66%) was recorded in variety Pusa Giant and the minimum (63.22) in Washington. The maximum seed germination (92.50%) was recorded in control while the minimum (20.75%) was with 5000ppm of EMS treatment. The maximum and minimum plant heights were noted 28.69cm and 18.78cm in variety Pusa Giant and Pusa Dwarf, respectively at three month stage. The maximum plant height (26.57cm) was recorded under control which was followed by 2000ppm, 1000ppm and 3000ppm of EMS solution. The maximum as well as minimum stem girths (0.313cm and 0.246cm) were recorded in variety Pusa Giant and Pusa Dwarf, respectively. The maximum stem girth (0.336cm) was recorded under 2000ppm of EMS treatment. Maximum as well as minimum leaves (25.500 and 17.167) were noted in variety Pusa Giant and Pusa Dwarf, respectively. The maximum leaves (25.917) were recorded under 2000ppm of EMS solution. The maximum and minimum petiole lengths (22.667cm and 18.572cm) were noted under Pusa Giant and Pusa Dwarf varieties, respectively. The maximum as well as minimum petiole lengths were recorded under 2000ppm and 5000ppm of EMS treatment. As is evident that EMS @2000ppm was most effective for development of vigour rather than other concentrations where as 5000ppm of EMS drastically reduced the vigour of the plant. Thus, on

observation of the data it was found that for development of ultra dwarf strains of papaya, higher concentrations of EMS will be effective for successful improvement of papaya cultivars.

1. Introduction

Fruits are indispensable part of human diet from time immemorial. India produced 74.878 MT fruits from 6.383 M ha area. Papaya is most important fruit with 4th position in production (4196000 MT) from 106000 ha area among the fruits in India (Indian Horticulture Database, 2011). It is native to Tropical America, good source of medicinal as well as nutritive value and 2nd rich source of carotene which is precursor of Vitamin-A followed by mango. Papaya belongs to the family *Caricaceae* and genus *Carica* having about 40 species. The papaya is believed to be native to southern Mexico, Costa Rica and neighbouring Central America. It is now present in every tropical and subtropical country. Only *Carica papaya* produces edible fruits.

2. Materials and Methods

The present experiment was conducted during 2011-12 in the Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (Uttar Pradesh). Four varieties of papaya- Pusa Dwarf, Pant papaya 1, Pusa Giant and Washington were taken. Prior to sowing of papaya seed in the plastic container, garden soil, vermin-compost and sand were mixed thoroughly. The design adapted was two way Factorial experiment.

3. Experimental Results



COTROL (T0) T1(1000ppm) T2 (2000ppm) T3 (3000ppm) T4 (4000ppm) T5 (5000ppm)

Plate 1: Effect of different concentrations of Ethyl methane sulphonate on Papaya Variety Pusa Dwarf at three month stage



COTROL (T0) T1(1000ppm) T2 (2000ppm) T3 (3000ppm) T4 (4000ppm) T5 (5000ppm)

Plate 2: Effect of different concentrations of Ethyl methanesulphonate on Papaya Variety Pant Papaya 1 at three month stage



COTROL (T0) T1(1000ppm) T2 (2000ppm) T3 (3000ppm) T4 (4000ppm) T5 (5000ppm)

Plate 3: Effect of different concentrations of Ethyl methane sulphonate on Papaya Variety Washington at three month stage.



COTROL (T0) T1(1000ppm) T2 (2000ppm) T3 (3000ppm) T4 (4000ppm) T5 (5000ppm)

Plate 4: Effect of different concentrations of Ethyl methane sulphonate on Papaya Variety Pusa Giant at three month stage.

Table 1: Effect on seed germination percentage of papaya varieties under different concentrations of EMS (Ethyl Methanesulphonate)

Factors	B (1) Control	B (2) (1000pp m)	B (3) (2000pp m)	B (4) (3000pp m)	B (5) (4000pp m)	B (6) (5000pp m)	Mean for A
Pusa Dwarf	93.000 (74.730)	81.000 (64.177)	71.667 (57.851)	64.333 (53.316)	52.667 (46.512)	20.333 (26.765)	63.833 (53.892)
Pant Papaya 1	92.000 (73.561)	84.667 (66.965)	75.333 (60.210)	62.000 (5130)	53.000 (46.702)	19.333 (26.063)	64.389 (54.238)
Washington	93.667 (75.460)	85.333 (67.473)	72.333 (58.247)	59.667 (50.561)	49.000 (44.409)	19.33 (26.053)	63.222 (53.700)
Pusa Giant	91.333 (72.893)	83.000 (65.641)	72.000 (58.045)	64.333 (53.316)	53.333 (46.894)	24.000 (29.319)	64.667 (54.35)
Means for B	92.500	83.500	72.833	62.583	52.000	20.750	
Factors	C.D. @ 5%						
Factor (V)	V= N.S.						
Factor (T)	T=1.7728						
Factor (VX T)	Vxt=3.546						

Maximum percentage of germination (64.66) was recorded in variety Pusa Giant and the minimum (63.22) in cultivars Washington. Rest of the varieties behaved in between. Although they were significantly at per with each other.

Table 2: Effect on plant height (cm) of papaya varieties under different concentrations of EMS (Ethyl Methanesulphonate) at one month stage

Factors	B (1) Cont rol	B (2) (1000pp m)	B (3) (2000pp m)	B (4) (3000pp m)	B (5) (4000p m)	B (6) (5000 ppm)	Mean for A
Pusa Dwarf A (1)	4.333	6.433	3.867	3.400	3.133	2.867	4.006
Pant Papaya 1A (2)	5.833	6.600	5.233	4.900	4.267	3.23	5.011
Washington A (3)	6.633	7.533	5.933	5.833	5.000	3.367	5.717
Pusa Giant A (4)	7.867	8.833	7.600	7.467	5.600	4.30	6.944
Means for B	6.167	7.350	5.658	5.400	4.500	3.442	
Factors	C.D. @ 5%						
Factor (V)	V = 0.1985						
Factor (T)	T = 0.2432						
Factor (VX T)	Vxt = 0.486						

Maximum plant height (6.944cm) was recorded in variety Pusa Giant and the minimum (4.006cm) in cultivar Pusa Dwarf. Rest of the varieties behaved in between and they were significantly different to each other.

Table 3: Effect on stem girth (cm) of papaya varieties under different concentrations of EMS (Ethyl Methanesulphonate) at one month stage.

Factors	B (1) Control	B (2) (1000pp m)	B (3) (2000pp m)	B (4) (3000pp m)	B (5) (4000pp m)	B (6) (5000pp m)	Mean for A
Pusa Dwarf A(1)	0.150	0.170	0.140	0.130	0.133	0.117	0.14
Pant Papaya 1 A(2)	0.173	0.210	0.167	0.147	0.143	0.113	0.15
Washington A(3)	0.200	0.240	0.183	0.173	0.157	0.140	0.18
Pusa Giant A(4)	0.237	0.290	0.213	0.197	0.183	0.153	0.21
Means for B	0.190	0.228	0.176	0.162	0.154	0.13	
Factors	C.D. @ 5%						
Factor (V)	0.0089						
Factor (T)	0.0109						
Factor (VX T)	0.022						

Table 2: Effect on plant height (cm) of papaya varieties under different concentrations of EMS (Ethyl Methanesulphonate) at one month stage

Factors	B (1) Control	B (2) (1000pp m)	B (3) (2000pp m)	B (4) (3000pp m)	B (5) (4000pp m)	B (6) (5000pp m)	Mean for A
Pusa Dwarf A (1)	4.333	6.433	3.867	3.400	3.133	2.867	4.006
Pant Papaya 1A(2)	5.833	6.600	5.233	4.900	4.267	3.23	5.011
Washington A (3)	6.633	7.533	5.933	5.833	5.000	3.367	5.717
Pusa Giant A (4)	7.867	8.833	7.600	7.467	5.600	4.30	6.944
Means for B	6.167	7.350	5.658	5.400	4.500	3.442	
Factors	C.D. @ 5%						
Factor (V)	V = 0.1985						
Factor (T)	T = 0.2432						
Factor (VX T)	Vxt = 0.486						

Table 3: Effect on stem girth (cm) of papaya varieties under different concentrations of EMS (Ethyl Methanesulphonate) at one month stage

Factors	B (1) Control	B (2) (1000pp m)	B (3) (2000pp m)	B (4) (3000pp m)	B (5) (4000pp m)	B (6) (5000pp m)	Mean for A
Pusa Dwarf A(1)	0.150	0.170	0.140	0.130	0.133	0.117	0.14
Pant Papaya 1 A(2)	0.173	0.210	0.167	0.147	0.143	0.113	0.15

Washington A(3)	0.200	0.240	0.183	0.173	0.157	0.140	0.18
Pusa Giant A(4)	0.237	0.290	0.213	0.197	0.183	0.153	0.21
Means for B	0.190	0.228	0.176	0.162	0.154	0.13	
Factors	C.D. @ 5%						
Factor (V)	0.0089						
Factor (T)	0.0109						
Factor (VX T)	0.022						

Maximum stem girth (0.21cm) was recorded in variety Pusa Giant and the minimum (0.14cm) in cultivar Pusa Dwarf. Rest of the varieties behaved in between and they were significantly different to each other.

Table 4: Effect on number of leaves of papaya varieties under different concentrations of EMS (Ethyl Methanesulphonate) at one month stage

Factors	B (1) Control	B (2) (1000ppm)	B (3) (2000ppm)	B (4) (3000ppm)	B (5) (4000ppm)	B (6) (5000ppm)	Mean for A
Pusa Dwarf A(1)	5.667	4.333	6.667	4.000	3.333	3.333	4.556
Pant Papaya 1 A(2)	7.000	5.333	8.000	5.333	4.667	4.333	5.778
Washington A(3)	7.667	6.333	9.333	6.000	5.667	5.333	6.722
Pusa Giant A(4)	8.333	7.333	11.333	7.000	6.667	6.333	7.833
Means for B	7.167	5.833	8.833	5.583	5.083	4.833	
Factors	C.D. @ 5%						
Factor (V)	0.3376						
Factor (T)	0.4135						
Factor (VX T)	0.N.S						

Maximum number of leaves (7.833) was recorded in variety Pusa Giant and the minimum (4.556) in cultivar Pusa Dwarf. Rest of the varieties behaved in between and they were significantly different to each other.

Table 5: Effect on petiole length (cm) of papaya varieties under different concentrations of EMS (Ethyl Methanesulphonate) at one month stage

Factors	B (1) Control	B (2) (1000ppm)	B (3) (2000ppm)	B (4) (3000ppm)	B (5) (4000ppm)	B (6) (5000ppm)	Mean for A
Pusa Dwarf A(1)	3.533	3.267	5.333	2.800	2.067	1.667	3.111
PantPapaya 1 A(2)	3.800	3.433	5.567	3.000	2.433	2.233	3.411
Washington A(3)	4.567	4.233	6.400	4.200	3.433	3.233	4.344

Pusa Giant A(4)	4.833	4.667	7.700	4.533	3.667	3.567	4.828
Means for B	4.183	3.900	6.250	3.633	2.900	2.675	
Factors	C.D. @ 5%						
Factor (V)	0.1198						
Factor (T)	0.1468						
Factor (VX T)	0.294						

Maximum petiole length (4.828cm) was recorded in variety Pusa Giant and the minimum (3.111) in cultivar Pusa Dwarf. Rest of the varieties behaved in between and they were significantly different to each other.

Table 6: Effect on plant height (cm) of papaya varieties under different concentrations of EMS (EthylMethanesulphonate) at three month stage

Factors	B (1) Contr ol	B (2) (1000pp m)	B (3) (2000p pm)	B (4) (3000pp m)	B (5) (4000pp m)	B (6) (5000pp m)	Mean for A
Pusa Dwarf A(1)	21.500	18.900	21.600	18.233	17.600	14.900	18.780
Pant Papaya 1 A(2)	26.500	22.567	24.600	20.233	19.933	17.567	21.900
Washington A(3)	26.667	22.533	21.100	20.400	20.133	17.533	21.390
Pusa Giant A(4)	31.633	28.700	32.200	29.500	26.933	23.211	28.690
Means for B	26.575	23.175	24.875	22.091	21.149	18.300	
Factors	C.D. @ 5%						
Factor (V)	0.7567						
Factor (T)	0.9268						
Factor (VX T)	N.S						

Maximum plant height (28.69cm) was recorded in variety Pusa Giant and the minimum (18.78cm) in cultivar Pusa Dwarf. Rest of the varieties behaved in between and they were significantly different to each other.

Table 7: Effect on stem girth (cm) of papaya varieties under different concentrations of EMS (Ethyl Methanesulphonate) at three month stage

Factors	B (1) Cont rol	B (2) (1000pp m)	B (3) (2000p pm)	B (4) (3000pp m)	B (5) (4000pp m)	B (6) (5000pp m)	Mean for A
Pusa Dwarf A(1)	0.253	0.243	0.293	0.230	0.240	0.213	0.246
Pant Papaya 1 A(2)	0.283	0.260	0.313	0.240	0.230	0.210	0.256
Washington A(3)	0.300	0.273	0.357	0.260	0.257	0.227	0.279
Pusa Giant A(4)	0.330	0.317	0.380	0.310	0.280	0.263	0.313
Means for B	0.292	0.273	0.336	0.260	0.252	0.228	

Factors	C.D. @ 5%
Factor (V)	0.0075
Factor (T)	0.0092
Factor (VX T)	0.018

Maximum stem girth (0.313cm) was recorded in variety Pusa Giant and the minimum (0.246cm) in cultivar Pusa Dwarf. Rest of the varieties behaved in between and they were significantly different to each other.

Table 8: Effect on number of leaves of papaya varieties under different concentrations of EMS (EthylMethanesulphonate) at three month stage

Factors	B (1) Contro l	B (2) (1000p pm)	B (3) (2000p pm)	B (4) (3000pp m)	B (5) (4000pp m)	B (6) (5000pp m)	Mean for A
Pusa Dwarf A(1)	20.000	16.333	23.000	15.667	14.333	13.667	17.167
Pant Papaya 1 A(2)	23.667	19.667	26.000	20.000	19.000	16.667	20.833
Washington A(3)	24.667	18.333	22.000	17.667	16.333	14.667	18.944
Pusa Giant A(4)	28.333	25.333	32.667	24.000	22.667	20.000	25.500
Means for B	24.167	19.917	25.917	19.333	18.083	16.250	
Factors	C.D. @ 5%						
Factor (V)	0.7314						
Factor (T)	0.8958						
Factor (VX T)	1.792						

Maximum number of leaves (25.500) was recorded in variety Pusa Giant and the minimum (17.167) in cultivar Pusa Dwarf. Rest of the varieties behaved in between and they were significantly different to each other.

Table 9: Effect on petiole length (cm) of papaya varieties under different concentrations of EMS (Ethyl Methanesulphonate) at three month stage

Factors	B (1) Contro l	B (2) (1000p pm)	B (3) (2000p pm)	B (4) (3000pp m)	B (5) (4000pp m)	B (6) (5000pp m)	Mean for A
Pusa Dwarf A(1)	21.167	19.400	19.967	18.000	17.200	15.700	18.572
Pant Papaya 1 A(2)	22.500	21.400	23.300	19.333	17.533	17.033	20.183
Washington A(3)	23.167	21.733	24.967	19.433	18.367	17.167	20.806
Pusa Giant A(4)	24.733	22.700	27.633	22.733	20.500	17.700	22.667
Means for B	22.892	21.308	23.967	19.875	18.400	16.900	
Factors	C.D. @ 5%						
Factor (V)	0.6284						
Factor (T)	0.7697						
Factor (VX T)	1.539						

Maximum petiole length (22.667cm) was recorded in variety Pusa Giant and the minimum (18.572cm) in cultivar Pusa Dwarf. Rest of the varieties behaved in between and they were significantly different to each other.

4. Discussion

In the present investigation the maximum seed germination percentage (92.50) was recorded in control or normal water medium. However, the minimum (20.75) was noted under the seeds treated with 5000ppm of EMS solution. Similarly, maximum percentage of germination (64.66) was recorded in variety Pusa Giant and the minimum (63.22) in cultivars Washington, however, they were significantly at par with each other. The maximum plant height (6.944cm) was recorded in variety Pusa Giant and the minimum (4.006cm) in cultivar Pusa Dwarf at one month stage. The maximum plant height (7.350cm) was recorded under 1000ppm of EMS solution which was followed by control and 2000ppm of EMS solution. Further, the maximum plant height (6.944cm) was recorded in variety Pusa Giant and the minimum (4.006cm) in cultivar Pusa Dwarf. It was due to genetic make up of Pusa Giant variety as compared to dwarfing nature of Pusa Dwarf. The maximum stem girth (0.21cm) was recorded in variety Pusa Giant and the minimum (0.14cm) in cultivar Pusa Dwarf. The maximum stem girth (0.228 cm) was recorded under 1000ppm of EMS solution which was followed by control, 2000ppm and 3000ppm of EMS solution. Thus, for development of ultra dwarf strains of papaya, higher concentrations of EMS will be effective for successful improvement of papaya cultivar. These findings are akin to results reported by Yadav and Padmaja (2004); Joshi and Verma (2005); Singh, and Singh (2007); Meena and Kumar (2007) , Kumar *et.al.* (2009), , Santosh *et al.*(2010), Singh and Kumar (2010), Singh *et al.* (2010) and Karunakaran *et al.* (2010).

5. Conclusion

The maximum percentage of germination (64.66) was recorded in variety Pusa Giant and the minimum (63.22) in cultivars Washington. The maximum plant height (28.69cm) was recorded in variety Pusa Giant and the minimum (18.78cm) in cultivar Pusa Dwarf. Maximum plant height (26.57cm) was recorded under control which was followed by 2000ppm, 1000ppm and 3000ppm of EMS solution. Maximum stem girth (0.336cm) was recorded under 2000ppm of EMS solution which was followed by control, 1000ppm and 3000ppm of EMS solution.

References

- [1] Karunakaran, G.; Ravishankar, H. and Dinesh, M.R. 2010. Genetical studies in papaya (*Carica papaya* L.). *Acta-Horticulturae*. 851: 103-108.\
- [2] Kumar, V. A. Kumari, R. U. Amutha, R. Kumar, T. S. Hepziba, S. J. Kumar, C. R. A. 2009 Effect of chemical mutagen on expression of characters in arid

- legume pulse-cowpea (*Vigna unguiculata* L. Walp.). *Research Journal of Agriculture and Biological Sciences*, 5 (6): 1115-1120.
- [3] Meena, A. L. Kumar, P. 2007 Mutagenic response of methyl methane sulphonate (MMS) on germination and plant height in *Lycopersicon esculentum* Mill. *Journal of Phytologica, Research*, 20 (2): 313-315.
- [4] Prashant Joshi and Verma, R. C. 2005 Ethyl methane sulphonate (EMS) induced (partial) asynaptic mutant in faba bean (*Vicia faba* L.). *Cytologia*, 70 (2): 143-147.
- [5] Santosh, L. C. Dinesh, M. R. Rekha, A. 2010 Mutagenic studies in papaya (*Carica papaya* L.). *Acta Horticulturae*, 851 109-112.
- [6] Singh, A. K. Singh, A. K. 2007 Biological influence of gamma rays and ethyl methane sulphonate and their synergistic effects in mungbean. *Journal of Food Legumes*, 20 (2): 153-155.
- [7] Singh, K. and Kumar, A. 2010. Genetic variability and correlation studies in papaya under Bihar conditions. *Acta-Horticulturae*. 851: 145-150.
- [8] Singh, S. V. Singh, D. B. Yadav, M. Roshan, R. K. Pebam, N. 2010 Effect of EMS on germination, growth and sensitivity of papaya (*Carica papaya* L.) cv. farm selection-1. *Acta Horticulturae*, 851, 113-116.
- [9] Yadav, P. B. S. Padmaja, V. 2004 Mutagen sensitivity of two pigeonpea cultivars to ethyl methane sulphonate and gamma rays. *Journal of Phytological Research*, 17 (1): 67-69