



Effect of gamma rays and ems on yield parameters in *Hibiscus sabdariffa*

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Abstract

Dry seeds of *Hibiscus Sabdariffa* (Family - Malvaceae) were irradiated with Gamma rays at 10 to 60 KR. Presoaked seeds (6 to 18 hrs.) were treated with 0.1 to 0.5 % EMS & for combination treatments, irradiated seeds were immersed in 0.2 % EMS. Observations on the yield parameters were recorded. It was observed that in the dose of gamma rays or concentration of EMS in alone or gamma rays followed by EMS in combination treatments showed minimum days for flowering & fruiting while maximum days required for flowering & fruiting were recorded at higher doses. The lower exposures of mutagenes showed maximum number of flowers, fruits, seeds & weight of seeds while drastic reduction was observed at higher doses.

Keywords: *hibiscus sabdariffa*, gamma rays, EMS, combination treatments

1. Introduction

Roselle (*Hibiscus sabdariffa*. L) belonging to family Malvaceae is an annual plant cultivated in tropical and subtropical regions for its stem fibres, edible calyces, leaves and seeds. Cultivation of the crop has been reported throughout the Indian subcontinents, part of Asia, America, Australia and throughout Africa (Cobley, 1968). The calyx is widely used for producing drinks or tea because of its high content of Anthocyanins and organic acids (Hong and Wroslad, 1990; Gomez-Leyva *et al.*, 2008; Cissé *et al.*, 2009) [15, 12, 7] as well as flavour and colour additives in the Manufacture of jam, liquor, and jellies (Akindahunsi and Olaleye, 2003) [1]. In ethno medicine, *H. sabdariffa* is traditionally used to deal with several health problems, including hypertension, pyrexia and liver disorders & microorganism growth. It is also used as a diuretic, sedative or digestive (Faraji and Tarkhani, 1999; Chen *et al.*, 2003; Akindahunsi and Olaleye, 2003) [1, 11, 5]. Mutagenesis has already been used for the improvement of many important characters such as size of plants, time of flowering, colors of fruits, ripening of fruits, self compatibility, self thinning and resistance to pathogenic organisms. Nowadays, the number of cultivars improved through mutation techniques increased rapidly (Maluszynski, 1995; Hearn, 2001; Majeed *et al.*, 2010) [21, 14, 20].

Gamma radiation induces several cytological, genetic (Harisand Jusoff, 2013) [13], morphogenetic (El-Sherif *et al.*, 2011), biochemical (Chandrashekar *et al.*, 2013) [4] and physiological alteration in cell and tissues of plants (Rahimi and Bahrani, 2011; Jan *et al.*, 2012) [26, 17]. Ashraf *et al.*, 2003 [3] have been reported to affect differentially the morphology, anatomy, biochemistry and physiology of plants depending on the radiation dose.

2. Materials and methods

Genetically pure seeds of *Hibiscus sabdariffa* (2n=72) obtained from Centre of Science for Villages (Dattapur, Dist.

Wardha) were used in these studies. Dry seeds were irradiated at Post Graduate Teaching Department of Chemistry, RTM Nagpur University, Nagpur for 10, 20, 30, 40, 50 and 60 KR. Dry and presoaked seeds (6, 12, and 18 Hours) were treated with freshly prepared 0.1, 0.2, 0.3, 0.4, 0.5% solutions of EMS for 18 hours with post soaking of 2 hours in deionized water. For combination treatments the gamma irradiated seeds (10, 20, 30, 40, 50 KR) were immersed in 0.2% EMS for 18 hours and handled in the same manner as those of alone EMS treatments. Control seeds were handled in the same manner as those of treated ones.

3. Results & discussion

3.1 Days required for flowering & fruiting

The data related to the days required for flowering & fruiting induced by different mutagenic treatments have been given in Tables 1-3 & Figs. 1-3.

a) Effect of Gamma rays

In control, the days required for flowering & fruiting were 115 & 172, respectively (Table 1). Number of days were increased with an increase in the dose of gamma rays (Figs. 1). However, less increase was induced by lower doses of gamma rays & more by higher ones. The days required for flowering & fruiting at 10 KR were 118 & 175, while at 60 KR as 132 & 186, respectively.

b) Effect of EMS

In dry and 6,12 & 18 hours pre - soaked control sets, the days required for flowering were 120,122,126 & 128 while days for fruiting were 170,173,174 & 176, respectively (Table 2). In all sets of EMS treatments, increase in days required for flowering & fruiting was directly proportional to the corresponding increase in duration of presoaking & EMS concentration. In all sets of EMS treatments (Dry 6,12 & 18 hours pre-soaked), the minimum days required for flowering (123, 125, 127, 129) & fruiting (173, 175, 177, 179) were

recorded in 0.1 % EMS while maximum days required for flowering (133, 137, 139, 140) & fruiting (183, 185, 187, 189) were noted in 0.5 % EMS respectively (Fig. 2).

c) Effect of Gamma rays followed by EMS

In control, the days required for flowering 118 & fruiting were 173 (Table 3). Number of days were increased with increase in the dose of gamma rays followed by EMS concentration (Fig - 3). However, less increase was induced by lower and more by higher doses. The days required for flowering &

fruiting at 10 KR + 0.2 % EMS were 120 & 175 while in 50 KR + 0.2 % EMS they were 128 & 184 respectively.

The minimum number of days taken to flowering was observed by Ramachandran and Goud (1983) in Safflower at 60 KR of gamma rays when compared to EMS and the control. The number of pods per plant considerably increased as compared to the control. This is supported by reports of Singh and Malhotra (1970) [32] in green gram and Swaminathan (1973) [35] who stated that an increase in the yield of pulses could be achieved by enhancing pod number

Table 1: Effect of gamma rays on flowering, fruiting and seeds.

Sr. No.	Doses	Days required for flowering	Days required for fruiting	No. Of flowers per plant	No. Of fruits per plant	No. Of seeds per fruit	Weight of 100 seeds(gms)
1	Control	115	172	12	11.6	15.6	2.21
2	10 KR	118	175	10.2	10.6	15.0	2.17
3	20 KR	121	177	9.4	9.4	14.6	2.11
4	30 KR	124	180	8.6	8.2	14.0	2.03
5	40 KR	126	183	7.8	6.8	12.4	1.83
6	50 KR	129	185	6.8	6.4	12.0	1.75
7	60 KR	132	186	6.2	5.8	11.6	1.63

gms = Grams

Table 2: Effect of EMS treatment on flowering, fruiting and seeds.

Sr. No.	Doses	Days required for flowering	Days required for fruiting	No. Of flowers per plant	No. Of fruits per plant	No. Of seeds per fruit	Weight of 100 seeds (gms)
1	Control (DRY)	120	170	13.2	12.0	17.2	2.56
2	Dry 18h 0.1 EMS	123	173	12.0	10.0	14.8	2.47
3	Dry 18h 0.2 EMS	126	175	11.2	9.0	14	2.38
4	Dry 18h 0.3 EMS	129	177	10.8	8.2	12.8	2.0
5	Dry 18h 0.4 EMS	131	180	9.8	7.2	12.0	1.83
6	Dry 18h 0.5 EMS	133	183	7.2	6.6	10.8	1.60
1	Control (6 h psw)	122	173	12.2	10.4	16.8	2.50
2	6 h psw+18h 0.1 EMS	125	175	11.0	9.6	13.8	2.43
3	6 h psw+18h 0.2 EMS	128	177	10.4	8.0	13.2	2.31
4	6 h psw+18h 0.3 EMS	132	179	10.0	7.4	11.8	1.87
5	6 h psw 18h 0.4 EMS	135	182	8.8	7.0	11.0	1.65
6	6h psw+18h 0.5 EMS	137	185	6.4	6.2	10.4	1.53
1	Control (12h psw)	126	174	11.2	9.8	16.2	2.42
2	12h psw 18h 0.1 EMS	127	177	10.0	8.6	12.8	2.35
3	12hpsw+18h 0.2 EMS	129	179	9.6	7.6	12.2	2.23
4	12h psw+18h 0.3 EMS	134	181	9.2	7.0	11.0	1.62
5	12h psw+18h 0.4 EMS	137	184	7.8	6.6	10.2	1.52
6	12h psw+18h 0.5 EMS	139	187	6.0	5.6	9.6	1.42
1	Control (18h psw)	128	176	10.0	8.8	14.4	2.25
2	18h psw+18h 0.1 EMS	129	179	8.6	7.6	11.6	2.28
3	18h psw+18h 0.2 EMS	130	181	8.2	6.6	10.8	2.12
4	18h psw+18h 0.3 EMS	136	184	7.8	6.0	10.0	1.53
5	18h psw+18h 0.4 EMS	139	187	6.8	5.6	9.4	1.43
6	18h psw+18h 0.5 EMS	140	189	5.0	4.8	8.8	1.31

h = hours. psw = pre-soaked in water. gms = Grams

Table 3: Effect of gamma rays followed by EMS treatments on days required for flowering, fruiting & Seeds

Sr. No.	Doses	Days required for flowering	Days required for fruiting	No. Of flowers per plant	No. Of fruits per plant	No. Of seeds per fruit	Weight of 100 seeds (gms)
1	Control	118	173	12.0	11.0	15.0	2.07
2	10KR+18 h 0.2 EMS	120	175	9.4	9.8	14.4	2.00
3	20KR+18 h 0.2 EMS	121	177	8.4	8.8	13.6	1.92
4	30 KR+18 h 0.2 EMS	124	181	7.6	7.4	12.4	1.83
5	40 KR+18 h 0.2 EMS	127	183	6.4	6.4	11.2	1.80
6	50 KR+18 h 0.2 EMS	128	184	6.0	5.8	11.0	1.71

h = hours. gms = Grams

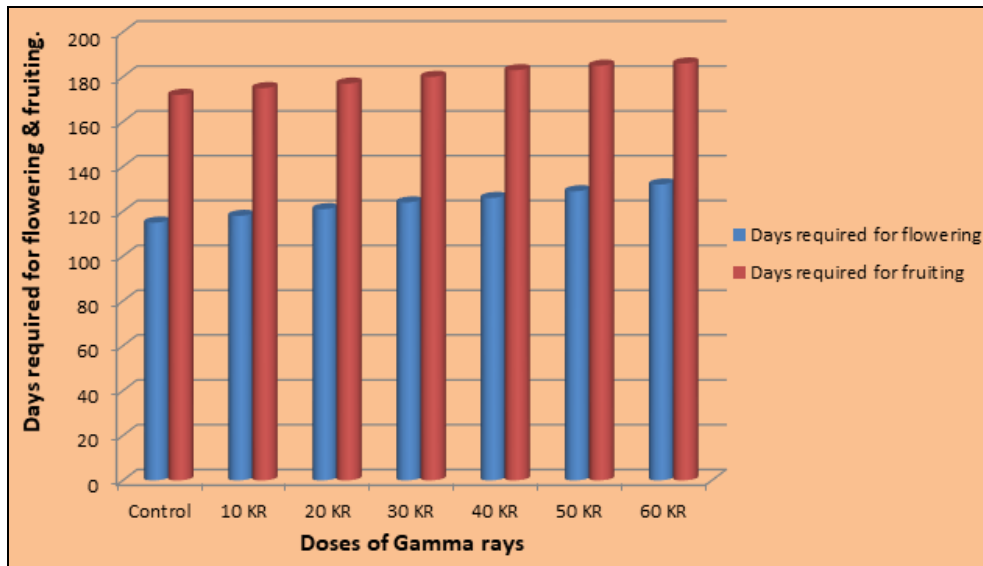


Fig 1: Effect of gamma rays on days required for flowering and fruiting.

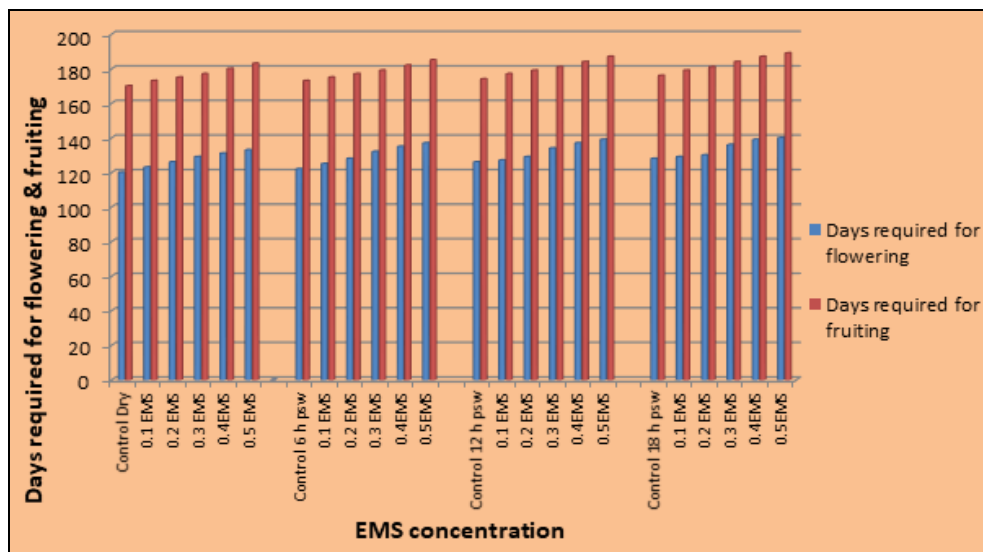


Fig 2: Effect of EMS on days required for flowering and fruiting.

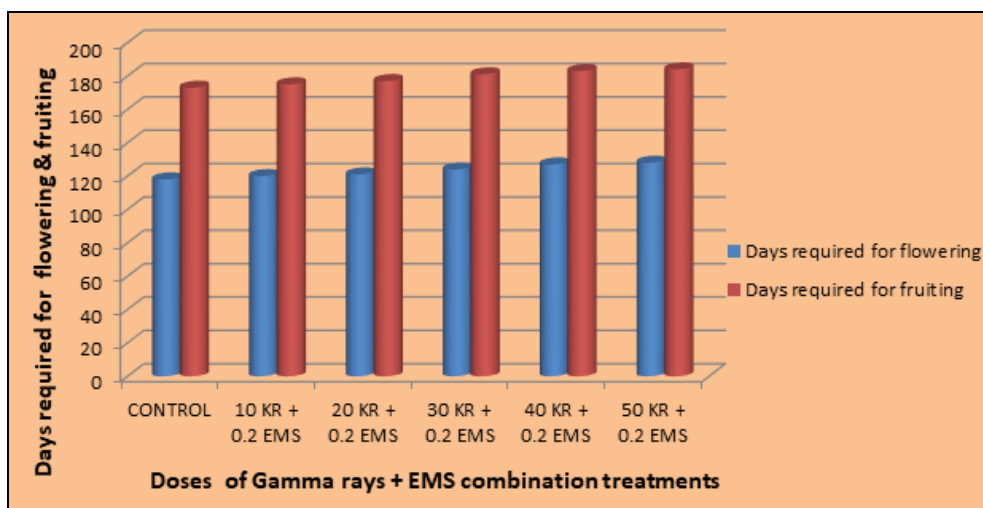


Fig 3: Effect of gamma rays followed by EMS on days required for flowering and fruiting.

3.2 Number of Flowers & Fruits per plant

Gamma irradiation, EMS treatments and gamma rays followed by EMS treatments showed effect on average number of flower & fruits as mentioned in Tables 1-3 & Figs. 4-6.

a) Effect of Gamma rays

In control, the number of flowers & fruits per plant were 12 & 11.6 respectively (Table 1). Number of flowers & fruits were decreased with increasing doses of gamma rays (Fig.4). However, less decrease was induced by higher doses of gamma rays and more by lower doses. The number of flowers & fruits per plant were 10.2 & 10.6 in 10 KR while the 6.2 & 5.8 in 60 KR.

b) Effect of EMS

In dry and 6,12 & 18 hours pre-soaked control sets, the number of flowers & fruits per plant were 13.2, 12.2, 11.2, 10 & 12, 10.4, 9.8, 8.8, respectively (Table 2).EMS in alone treatment induced reduction in average number of flowers & fruits with the corresponding increase in duration of pre-soaking & EMS concentration. In all sets of EMS

treatments (Dry, 6,12 & 18 hours pre-soaked),the number of flowers & fruits was maximum i.e,12, 11, 11.2, 10 & 12, 9.6, 8.6,7.6 respectively, in the treatment with 0.1 % EMS. While it was minimum i.e. 7.2, 6.4, 6, 5 & 6.6, 6.2, 5.6, 4.8, respectively in 0.5 % EMS. (Fig. 5).

c) Effect of Gamma rays followed by EMS

In control, the number of flowers & fruits per plant were 12 & 11, respectively (Table 3). The number of flowers & fruits per plant were decreased with an increase in the dose / concentration of gamma rays followed by EMS. The number of flowers & fruits per plant were the highest (9.4 & 9.8) in 10 KR + 0.2 % EMS & the lowest (6 & 5.8) in 50 KR + 0.2 EMS (Fig.6)

Increased number of fruits per plant as a result of gamma irradiation was recorded by (Sundaravadevelu *et al.*, 2006., Dubey *et al.*, 2007; Mishra *et al.*,2007; Sharma and Mishra, 2007., Sujaya-Das *et al.*, 2007) [34, 9, 24, 28, 33]. Excessive nitrogen and manure reduced fruit number and yield but enhances plant growth as earlier reported by (Aliyu *et al.*, 1996)^[2].

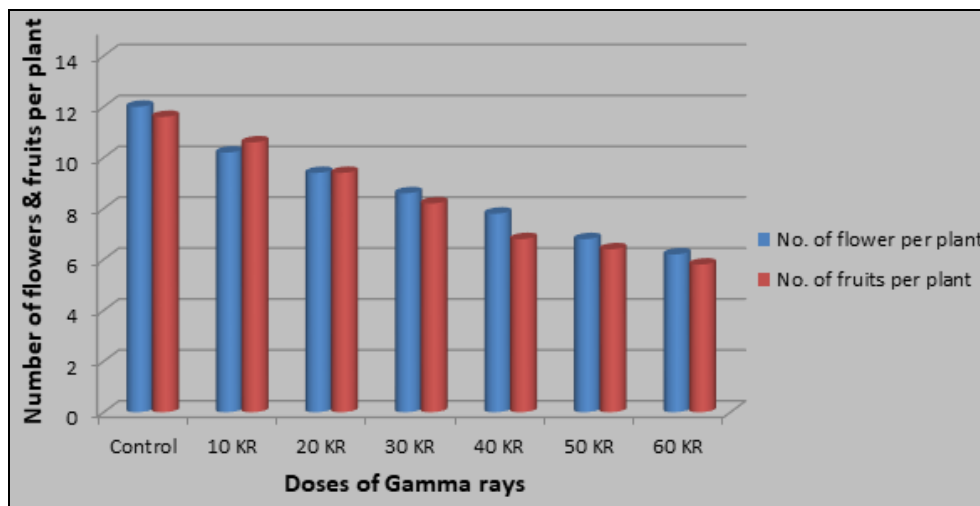


Fig 4: Effect of gamma rays on number of flowers and fruits per plant.

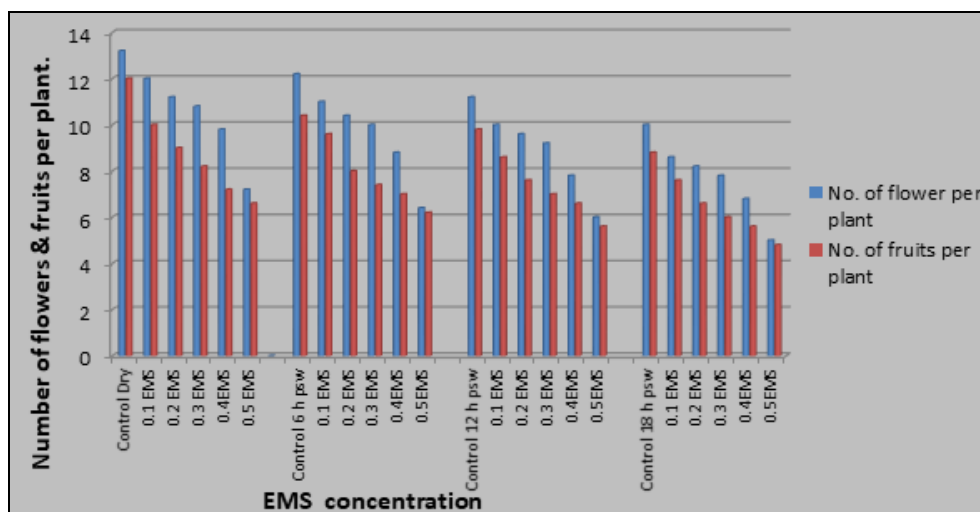


Fig 5: Effect of EMS on number of flowers and fruits per plant.

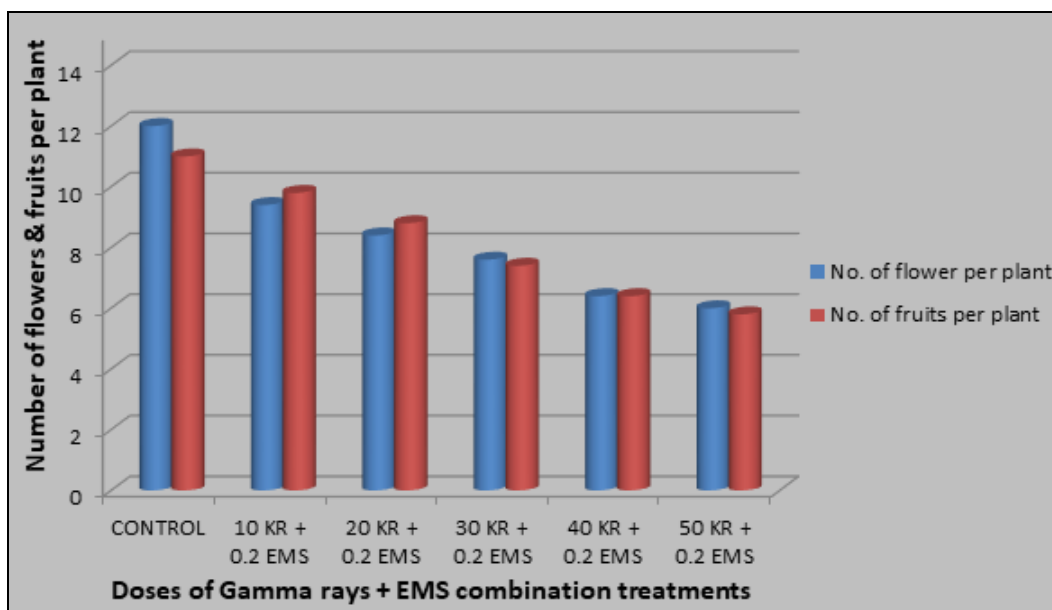


Fig 6: Effect of gamma rays followed by EMS on number of flowers and fruits per plant.

3.3 Number of Seeds per fruit & weight of 100 seeds (Gm)

The data related to the effect of mutagens on number of seeds per fruit & weight of 100 seeds have been given in Tables 1-3 & Figs, 7-9.

a) Effect of Gamma rays

In control, the number of seeds per fruit & weight of 100 seeds were 15.6 & 2.21, respectively (Table 1). The number of seeds per fruit & weight of 100 seeds were decreased with an increase in the dose of gamma rays (Fig.7). However, lower doses of gamma rays reduced number of seeds per fruit & weight of 100 seeds to smaller extent while drastic reduction was observed with higher doses. The number of seeds per fruit & weight of 100 seeds recorded in 10 KR were 15 & 2.17, while in 60 KR they were 11.6 & 1.63, respectively.

b) Effect of EMS

In dry and 6, 12 & 18 hours pre-soaked control sets, the number of seeds per fruit were 17.2, 16.8, 16.2 & weight of 100 seeds 14.4 & 2.56, 2.50, 2.42, 2.25, respectively (Table2). The gradual reduction in number of seeds per fruit & weight of 100 seeds was recorded with the corresponding increase in duration of presoaking & EMS concentration. In all sets of EMS treatments (dry, 6 hrs. 12 hrs. & 18 hrs. pre-soaked), the number of seeds per fruit were 14.8, 13.8, 12.8, 11.6 while weight of 100 seeds were 2.56, 2.43, 2.35, 2.28, respectively in 0.1 % EMS. The number of seeds per fruit were 10.8, 10.4, 9.6, 8.8 & weight of 100 seeds 1.60, 1.53, 1.42, 1.31 were observed in 0.5 % EMS, respectively (Fig.8).

c) Effect of Gamma rays followed by EMS

In control, the number of seeds per fruit & weight of 100

seeds were 15 & 2.07 respectively (Table 3). The number of seeds per fruit & weight of 100 seeds were decreased with an increase in the dose of gamma rays followed by EMS concentration. The number of seeds per fruit & weight of 100 seeds were 14.4 & 2 in 10 KR+ 0.2 % EMS while in 50 KR + 0.2 EMS they were 11 & 1.71, respectively (Fig. 9).

The seed set per capsule decreased with the increase of dES concentrations in *H. sabdariffa* (Shrivastava *et al.*, 2008) [30]. High coefficients of phenotypic (PCV) and genotypic variation (GCV) were observed for number of pods per plant followed by number of cluster per plant, number of seeds per pod, and seed yield per plant. Similar results were also reported by Cherian (2000) [6] and Manju and Sreelathakumary (2002) [22] in *Capsicum chinense* Jacq. EMS showed high phenotypic and genotypic in number of clusters per plant, number of pods per plant and number of seeds per pod.

Khurana and Sandhu (1972) [18] obtained the highest phenotypic and genotypic values in number of pods per plant and seed yield per plant in soybean. The 100 seed weight in the mutant plants was more than double in the parent of M3 generation (Wani and Anis, 2001) [36].

Several investigators have also studied mutagenic effectiveness in various crops such as Nerkar (1977) [25] in *Lathyrus sativus*, Jabaraj and Marappan (1981) [16] in green gram, Mehta and Pandey (1998) [23] in french bean, Singh and *et al.* (2001) in Mung bean, Sassi Kumar *et al.*, (2003) [19] in lima bean, Sharma *et al.*, (2005) [29] in urd bean, using mutagens Gamma rays, and EMS and reported higher mutagenic effectiveness at lower doses.

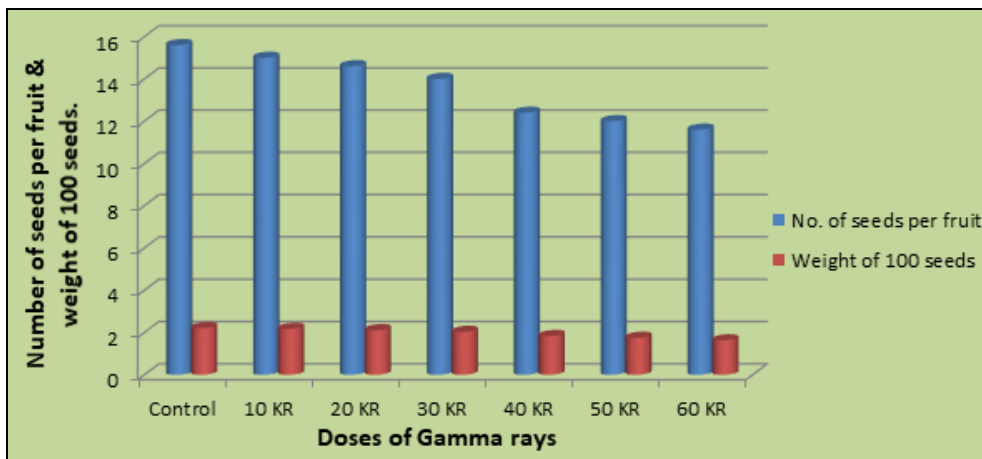


Fig 7: Effect of gamma rays on number of seeds per fruit and weight of 100 seeds (Gm).

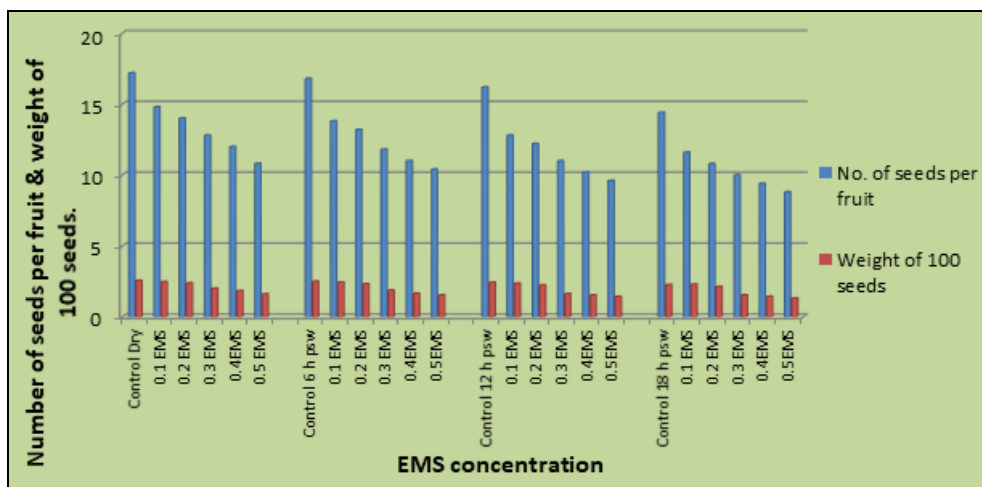


Fig 8: Effect of EMS on number of seeds per fruit and weight of 100 seeds (Gm).

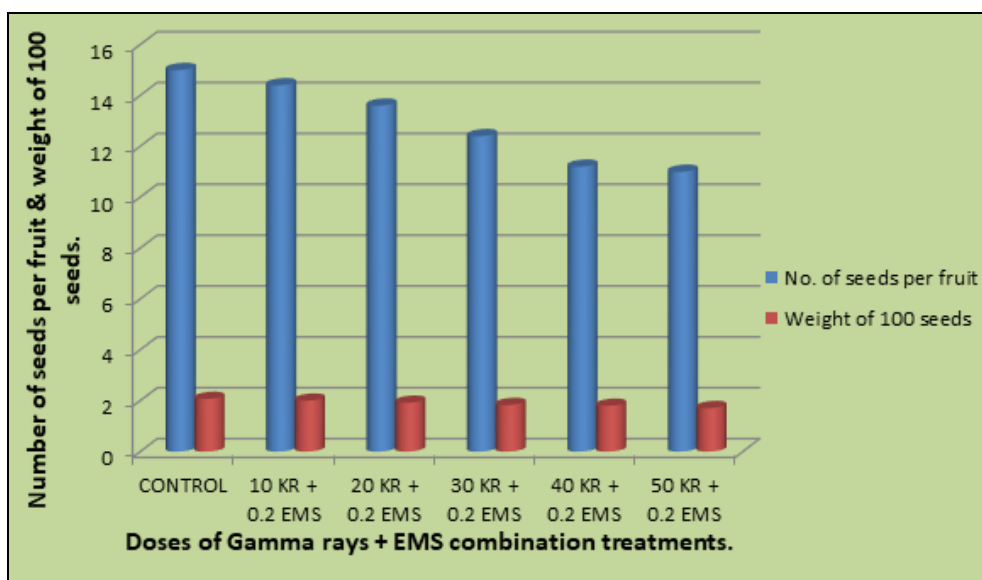


Fig 9: Effect of gamma rays followed by EMS on number of seeds per fruit and weight of 100 seeds (Gm).

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