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Development of Early Maturing Mutants in Finger Millet

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Abstract

An investigation was carried out in TRY1 finger millet variety to develop the mutants for desirable traits. Healthy and dry seeds was exposed to ethyl methane sulphonate (EMS) viz., 15%, 0.30%, 0.45%, 0.60% and 0.75%. Seedling parameters and yield contributing characters were analyzed. In laboratory experiment, germination percentage (90%), the maximum root length of 5.71 cm and shoot length of 3.86 cm on 13th day were observed in the treatment of 0.15% of EMS. The seedling length of 9.58 cm for 0.15% EMS treatment which showed the maximum length among all the treatments. In case of vigour index, maximum vigour index of 913.26 was recorded at 0.15% of EMS treatment. The minimum vigour index was observed in 0.75% of EMS treatment. In case of Stress tolerant index, 0.30% of EMS treatment recorded the maximum stress tolerant index of 114.89 than any other EMS treatments. By considering all these results, 0.15% EMS treatment showed the desirable values to the said parameters than any other treatments. In M_1 generation, 0.15% of EMS treated plants showed a early flowering among all other treatments. The maximum plant height, tillers per plant, productive tillers per plant, finger number, finger length, 1000 grain weight and grain yield were observed in 0.15% EMS concentration. Hence, it was observed that 0.15% concentration showed the desirable values and these values were decreased with increasing concentration.

Keywords: Ragi, EMS, Chemical mutagenesis.

Introduction

In India, finger millet has been grown over an area of 2.15 million hectares with an average production of 2.68 million tonnes (Anon., 2003). In Tamil nadu, the area under ragi cultivation is about 1.29 lakh hactares during 2001-02 with a production and productivity of 2.353 lakh metric tonnes and 1884 kg/ha respectively and it was declined to 0.828 lakh hactares during 2011-12 with a production and productivity of 2.249 lakh metric tonnes and 2715 kg/ha which is about 34% reduction in area and 4%in production

This may be due to the crop cultivation in neglected and ill fertile soil under rainfed condition. Poor yield with an improper marketing chain divert the farmer to go for other major cereals crop cultivation which is not having the balanced nutrients. Hence development of high yielding varieties with climate resilient capacity is a need of the hour to increase the area under ragi. The yield potential of this crop is low and plagued with a number of diseases. Though the crop has been important over centuries, more concentrated research efforts are geared in recent years to evolve improved varieties and develop production technology. Ragi is commonly called as "Nutritious millet" as the grains are nutritionally superior to many cereals providing fair amount of proteins, minerals, calcium and vitamins in abundance to the people. It is the cheapest and preferred food crop of economically suppressed but physically hard working people. It is appreciated by the people, because it can digest slowly thereby furnish energy for hard work throughout the day. Finger millet meets the first and most needs of mankind, the energy and hunger satisfaction. It leaves a sense of being well fed to any farmer. The protein of finger millet has been reported to possess a fairly high biological value, which is needed for the maintenance of nitrogen equilibrium of the body. The higher fibre content of finger millet helps in many ways as it prevents constipation, high cholesterol formation and intestinal cancer. Hence, people suffering from diabetics are advised to eat finger millet and other small millets instead of rice according to the report given by Hadimani and Malleshi[1].

Unlike hybridization and selection, mutation breeding has the advantage of improving a defect in an otherwise elite cultivar, without losing its agronomic and quality characteristics. Mutation breeding is the only straightforward alternative for crop improvement in plants having small size florets which is very difficult for emasculation and hybridization. Artificial hybridization and recombination breeding for varietal improvement in finger millet (*Eleusine coracana* Gaertn.) could not be taken up in a big way because of small floret size. Under this situation, the induced mutagenesis is one of the alternative breeding methods which can be applied to enhance the variability and correct one or more defects of a cultivar. The present mutation breeding project, aims to report the effect of, ethyl methane sulphonate on mutation frequency and spectrum in a established variety of finger millet TRY 1.

Kumuda Chandra muduli *et.al* [2] observed chemically mutant varieties showed greater genetic divergence in finger millet. Uma *et al*. [3] reported the differences in tolerance were observed only when the seedlings were subjected to a proceeding mild induction stress, [-0.6 Mpa PEG or 200mm Nacl]. He concluded that synthesis of stress proteins is correlated with the observed variation in acquired tolerance of the two genotypes. He also dealt with or without induction.

Binod Kumar *et al*.[4] observed the mutants treated varieties shows dwarf plants with leaning growth habit, grassy non flowering plant type, tall with elongated internodes, panicle with gappy rachis, panicle with extra large glumes,panicle with extra distal thumb, sterile panicle with twisted fingers, and profusely branched panicle. These deviated plants showed high degree of pollen sterility. Pollen fertility reduced gradually with increasing doses. Effectiveness was high in lower dose. Chopra[5] observed that the effect of ploidy on mutation in different crop species by conducting the experiment on effect of combined treatments of mutagens such as (EMS) Ethyl Methyl sulfonate, hydroxyl amine (HA), X-RAYS, UV –rays and gamma rays. He dealt with induced mutations in phylogenetic studies , Muduli and Misra[2] observed plant characters changes with mutagens, their doses and variety. The changes occur in plant height, tillers/plant, fingers/ear, finger length, ear weight/ plant and yield/plant. Mutagenic treatment varieties produced significantly higher yield than their respective parent variety.

Ganapathy *et al*[6] reported that mutagenic effectiveness decreased with the increase in dose of mutagen indicating that negative relationship between effectiveness and dose of mutagen. Senapati and Misra[7] observed that the gamma rays and EMS treatments appeared to be effective in producing high yielding progenies/ cultures in blackgram. Pre -soaking seeds before treatment enhances sensitivity to many chemical mutagens as reported by Singh and Sinha[8]. Sunita Bhosle *et al*.[9] evidenced that total mutagenic efficiency revealed highest value at the higher concentration/dose in both the varieties of cluster bean in majority of the treatments. Dhakshanamoorthy *et al*.[10] found that that the treatment of gamma rays were found to be greater compared to those of EMS treatments.

Sankara Vadivoo *et al*[11] reported that the 1000 grain weight variability in the different concentration of EMS treatments and Gamma radiation treatment. Renuga Agarwal and Nitin Agarwal [12] observed that that assessment of phylogenetic relationship is an important component of any successful crop improvement programme, as mild relations of the crop species.

Material and Methods

Laboratory experiment: Treating the seeds with EMS: Dry and dormant seeds with 10% moisture content of Variety TRY 1 finger millet was used for treatment with EMS in five different concentrations (0.15%, 0.30%, 0.45%, 0.60% and 0.75%) along with control. One hundred seeds were used for each treatment. Seed was presoaked in water for 10 hours and soaked with EMS for 6 hrs. The observation on germination and seedling growth were taken on 3rd , 10th and 13th day after sowing by counting the number of seeds germinated for each treatment and recorded the root and shoot length from the germinated seedlings.

Raising the M1 Generation: Each treated M seeds was raised on a nursery bed and transferred to the main field on 23 DAS. The M generation was raised on a row length of 3 m with the spacing of 30x10 cm with the plot size of 3x9.6 m. The M_1 generation was grown and harvested as bulk.

Observations recorded: i. Days to flowering, ii. Plant height(cm), iii. Productive tillers, iv. Tillers per plant, v. Finger number, vi. Finger length (cm), vii. 1000 grain weight, viii. Grain yield.

Datas were subjected to analysis of variance by using AGRES software package. The variations were determined by the following parameters;

Statistical Analysis: Analysis of variance (ANOVA): Analysis of variance (ANOVA) was done separately for each trait for all treatments. The laboratory experiments were conducted in Completely Randomized Design (CRD) for laboratory experiment and RBD for M_1 generation. Data entry and analysis were done using Microsoft Excel and Agres. The model of the analysis of variance is given below:

Sources	d.f	MSS	F
Replication	r-1	RMSS	TMSS/EMSS
Treatments	t-1	TMSS	
Error	(r-1)(t-1)	EMSS	
Total	(rt-1)		

Where, t = Number of treatments (genotypes), r = Number of replications.

The standard error was calculated as S.Ed = $\sqrt{EMSS/r}$

Significance of treatment mean square and replication mean square were tested by comparing with error mean squares referring to 'F' table value at five percent level of probability.

Results and Discussion

Studies under Laboratory condition in M_1 generation: In case of seed germination, the seeds which were treated with EMS (0.15%) showed the highest germination percentage of 92%,94% and 90% in 3rd , 8th and 13th days respectively. The minimum seed germination percentage was recorded in the higher dose/ concentration of EMS (0.75%) as 85%, 86% and 85% in 3rd , 8th and 13th days respectively. Kumar and Mishra[13] reported that in okra (*Abelmoschus esculentus*), germination percentage generally decreased with increasing doses / concentrations of gamma rays and EMS.

All the EMS treatments showed a reduced root length as compared to control. Among EMS treatments, 0.15% treated seedlings showed a maximum root length of 2.80cm, 4.58cm and 5.71cm in 3rd, 8th and 13th days respectively as compared to the other treatments. All the treatments showed a reduced root length of 2.83 cm, 4.87 cm and 5.83cm in 3rd, 8th and 13th days respectively as compared to control.

The maximum shoot length of 1.80cm, 2.80 cm and 3.01 cm was observed in 3rd, 8th and 13th days respectively which are treated at the concentration of 0.15% EMS. All the treatments showed a reduced shoot length of 2.06 cm , 2.95cm, 3.51cm in 3rd, 8th and 13th days respectively as compared to control.

Seedling length of EMS treated plants at 0.15% dose exhibited the highest seedling length of 4.55 cm, 7.54 cm and 9.24 cm in 3rd, 8th and 13th days respectively as compared to other treatments. Maximum vigour index was recorded as 415.47, 655.54, and 841.12 at 3rd, 8th and 13th days respectively, at 0.15% EMS concentration. The minimum vigour index was recorded as 328.52, 550.78 and 64.846 in 3rd, 8th and 13th days respectively as compared to control for 0.75% of EMS.

The maximum stress tolerant index was observed from the seeds which were treated with 0.15% of EMS as 126.502, 119.02 and 110.22 in 3rd, 8th and 13th days respectively. The minimum stress tolerance index was observed for 0.75% of EMS as 106.18, 100.65, 64.88 in 3rd, 8th and 13th days respectively.

Table-1
Estimates of mean values and standard error of mean for seedling parameters on 3rd day

S.No	Dose/ concentration	Germination%	Root length (cm)	Shoot length(cm)	Seedling length(cm)	Vigour index	STI
1	CONTROL	95.33±0.94	2.93±0.35	2.06±0.12	4.93±0.48	427.07±0.16	130.18±077.51
2	0.15%	92.33±2.86	2.80±0.08	1.80±0.08	4.55±0.19	425.00±0.39	129.55± 180.78
3	0.30%	87.33±0.94	2.72±0.13	1.75±0.10	4.48±0.17	399.78±0.32	121.86±148.89
4	0.45%	86.33±1.33	2.67±0.09	1.71±0.06	4.33±0.11	397.35±0.18	121.12±086.18
5	0.60%	85.00±1.69	2.63±0.04	1.53±0.20	4.25±0.34	361.25±0.58	110.11±267.69
6	0.75%	85.00±0.81	2.36±0.08	1.53±0.08	3.86±0.16	328.05±0.21	106.18±77.51

Table-2
Estimates of mean values and standard error of mean for seedling parameters on 8th day

S.No	Dose/conc	Germination%	Root length(cm)	Shoot length(cm)	Seedling length(cm)	Vigour index	STI
1	CONTROL	97±1.20	4.87±0.08	2.95±0.09	7.72±0.18	718.78±0.14	130.50 ± 48.69
2	0.15%	94±3.29	4.58±0.09	2.80±0.10	7.54±0.12	655.54±0.25	119.02 ± 83.97
3	0.30%	89±1.56	4.46±0.04	2.67±0.03	7.39±0.20	645.36±0.51	117.17 ± 72.92
4	0.45%	89±1.41	4.19±0.08	2.63±0.03	7.10±0.07	605.28±0.14	109.88 ± 42.48
5	0.60%	88±2.58	4.08±0.16	2.3±0.08	6.38±0.24	566.15±0.29	102.78 ± 85.83
6	0.75%	85±0.81	3.94±0.11	2.1±0.07	6.04±0.19	550.78±0.34	100.68 ± 65.81

Table-3
Estimates of Mean Values And Standard Error of Mean for seedling parameters on 13th day

S.No	Dose/ conc	Germination %	Root length(cm)	Shoot length(cm)	Seedling length(cm)	Vigour index	STI
1	CONT	94±3.77	5.83±0.09	3.51±0.07	9.58±0.19	913.26±0.73	124.75 ± 286.25
2	0.15%	90±2.94	5.71±0.08	3.06±0.12	9.24±0.17	841.12±0.48	110.22 ± 245.10
3	0.30%	90±1.69	5.62±0.08	2.22±0.08	9.11±0.16	806.92±0.63	114.89 ± 187.29
4	0.45%	89±3.55	5.60±0.08	3.74±0.10	8.48±0.20	732.07±0.25	87.778 ± 164.75
5	0.60%	89±1.24	4.57±0.08	3.61±0.08	7.56±0.20	642.69±0.42	75.239 ± 150.08
6	0.75%	85±2.05	4.26±0.14	2.76±0.12	6.48±0.22	550.08±0.38	64.846 ± 129.46

Table-4
Estimates mean values and standard error of mean for different quantitative characters in M_1 Generation

Treatments	Days to flowering $\bar{X}$(SE)	Plant height (cm) $\bar{X}$(SE)	Tillers per plant (Nos) $\bar{X}$(SE)	Productive tillers (Nos) $\bar{X}$(SE)	Finger number (Nos) $\bar{X}$(SE)	Finger length (cm) $\bar{X}$(SE)	Thousand grain weight (Grams) $\bar{X}$(SE)	Grain yield (Grams) $\bar{X}$(SE)
Control	57.33	61.10	6.32	5.60	7.80	7.28	3.30	21.05
0.15	51.33 ±2.35	62.06 ±2.59	4.83±0.73	4.55±0.22	6.38±0.21	6.71±0.21	2.93±0.06	23.81±1.85
0.30	53.89 ±2.79	60.04 ±2.13	4.60±0.50	3.75±0.32	5.90± 0.28	6.27± 0.28	2.67±0.12	22.56±1.28
0.45	55.74 ±2.77	57.84 ±2.99	3.50±0.44	3.52±0.31	5.51±0.39	6.24 ±0.16	2.69±0.08	21.43±0.90
0.60	58.38± 3.05	58.76± 3.44	3.48±0.34	3.28±0.28	5.47± 0.30	5.93± 0.34	2.61±0.10	21.09±1.08
0.75	62.35 ±3.06	57.55± 2.03	3.49±0.26	3.15±0.35	4.70±0.28	5.41± 0.15	2.59±0.11	20.56±1.11

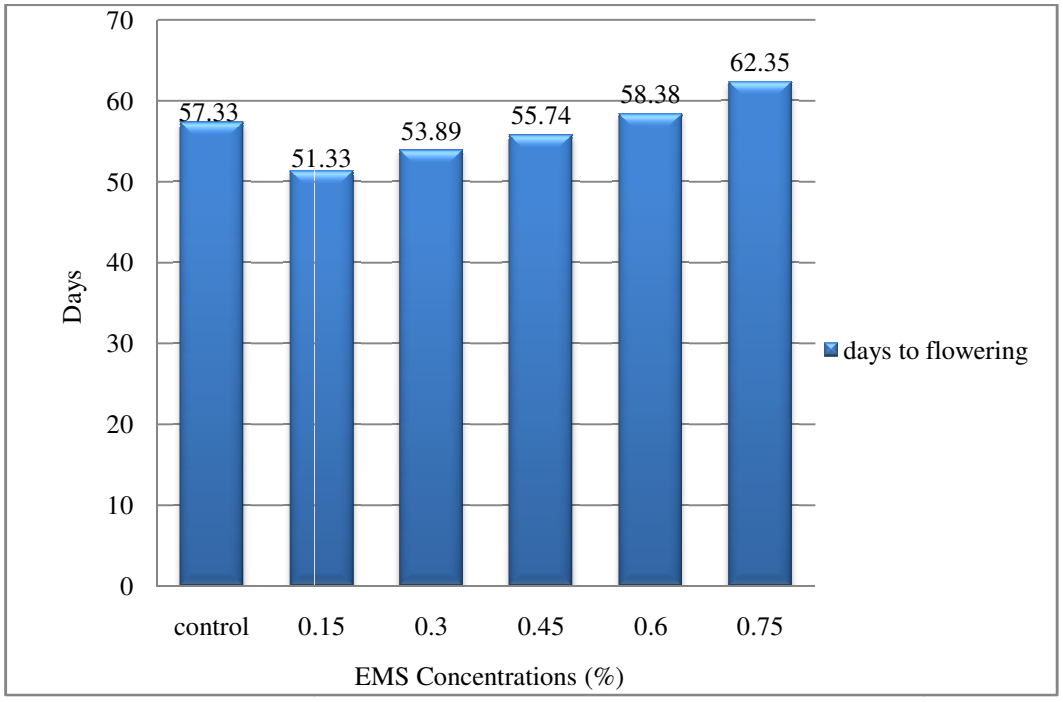

Figure-1
Treatment effect of mutagen on days to flowering

Studies under field condition in M_1 generation: Days to flowering was minimum of (51 days) was recorded with 0.15% of EMS. At the maximum concentration 0.75% of EMS, it exhibited 63 days to flowering which is the longest duration.

The present study coincides with a previous study in linseed by George and Nayar (1973). Early flowering was also reported in *Lathyrus sativus* L by Girhe and Choudhary[14]. These findings showed that gamma rays and EMS can change the days to flowering and fruit maturity.

Maximum plant height of 62cm is at maturity was observed in the plants which are treated at the concentration of 0.15% of ethyl methane sulphonate (EMS). The second best plant height (60.04 cm) is observed from the plant which are treated with EMS at 0.30%.

When comparing with the control [plant height= 61.10 cm], the plants which are emerged by treating the seeds with 0.75% of ethyl methane sulphonate (EMS) recorded the minimum plant height of 57.55 cm. Hence, its proved that the plant height decrease which the increasing concentration of the chemical mutagen EMS.

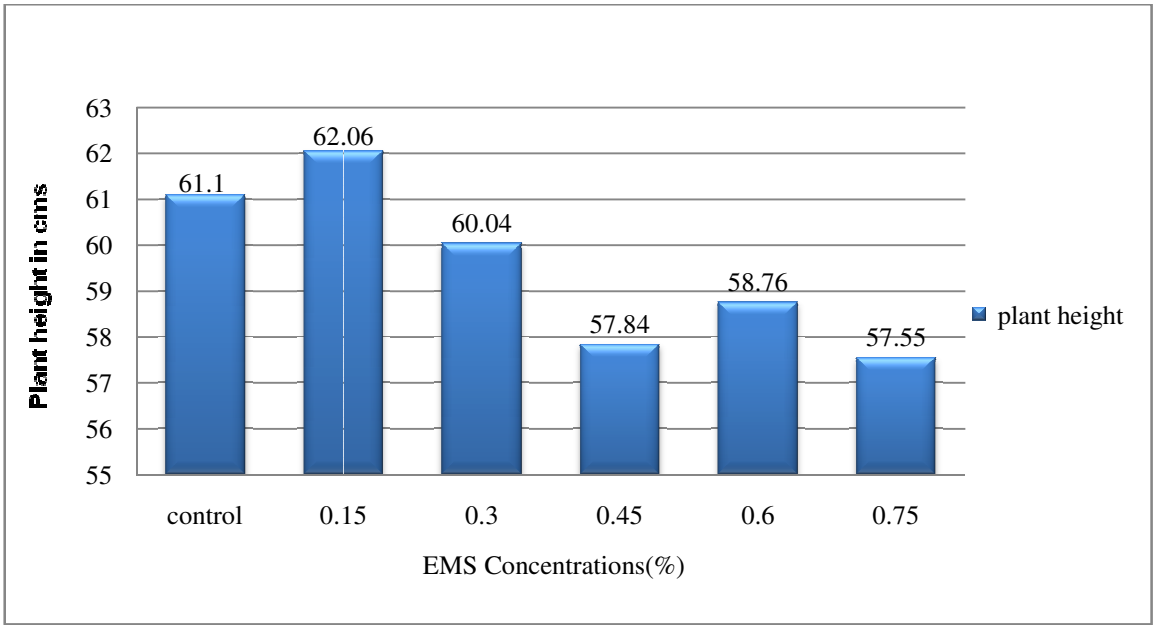

Figure-2
Treatment effect of mutagen on plant height

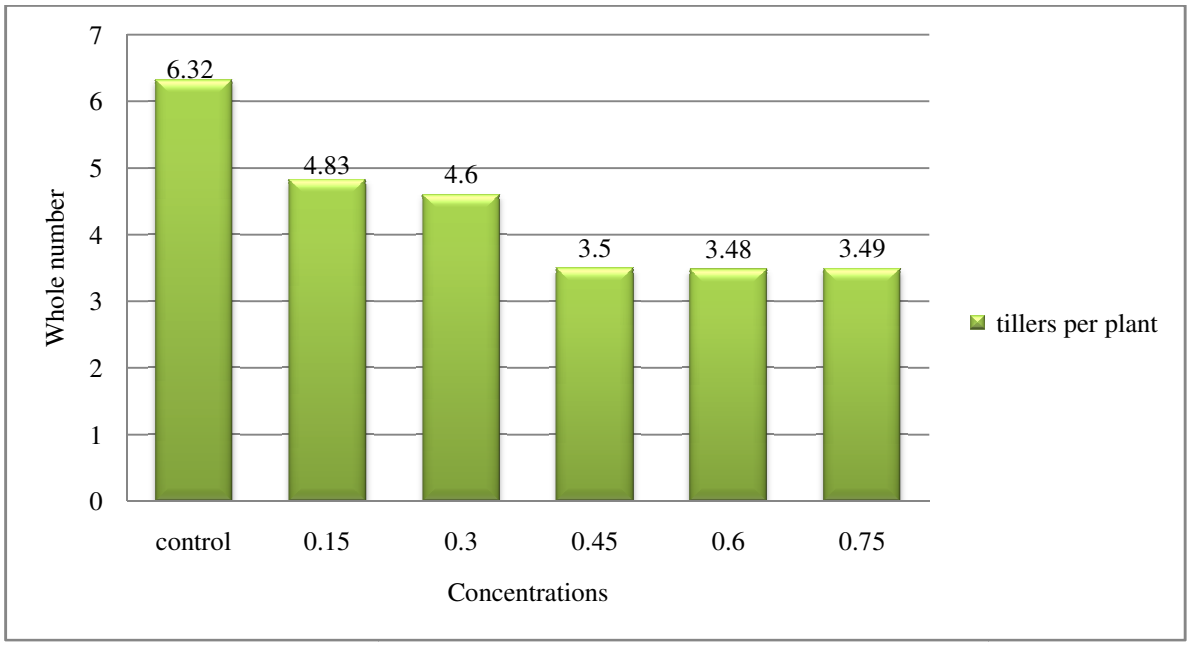

Figure-3
Treatment effect of mutagen on tillers per plant

Maximum number of tillers (4.83) per plant was recorded in 0.15 %. EMS. It showed an inhibitory effect when comparing with the control (6.32). The highest concentration of 0.75 % of EMS treated plants recorded the minimum tillers per plant of 3.49.

It could be seen that the maximum number of productive tillers per plant (4.55) was observed with 0.15%. EMS When considering the number of productive tillers per plant of control (5.60), the different treatments showed a reduced number of productive tillers per plant The plants were treated with 0.75% of EMS recorded the minimum productive tillers per plant (3.15) Muduli and Misra[2] observed plant characters changes in plant height, tillers/plant, fingers/ear, finger length, ear weight/ plant and yield/plant. These morphological changes in M_1 generation could be considered to be the secondary effect caused due to physiological disturbance.

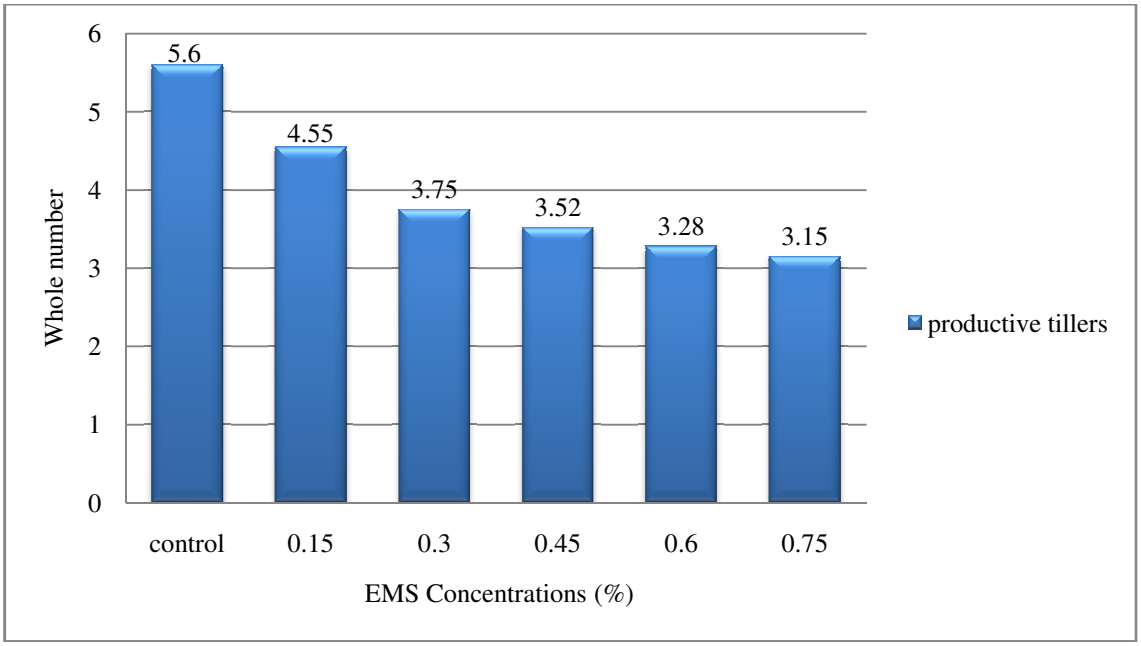

Figure-4
Treatment effect of mutagen on productive tillers per plant

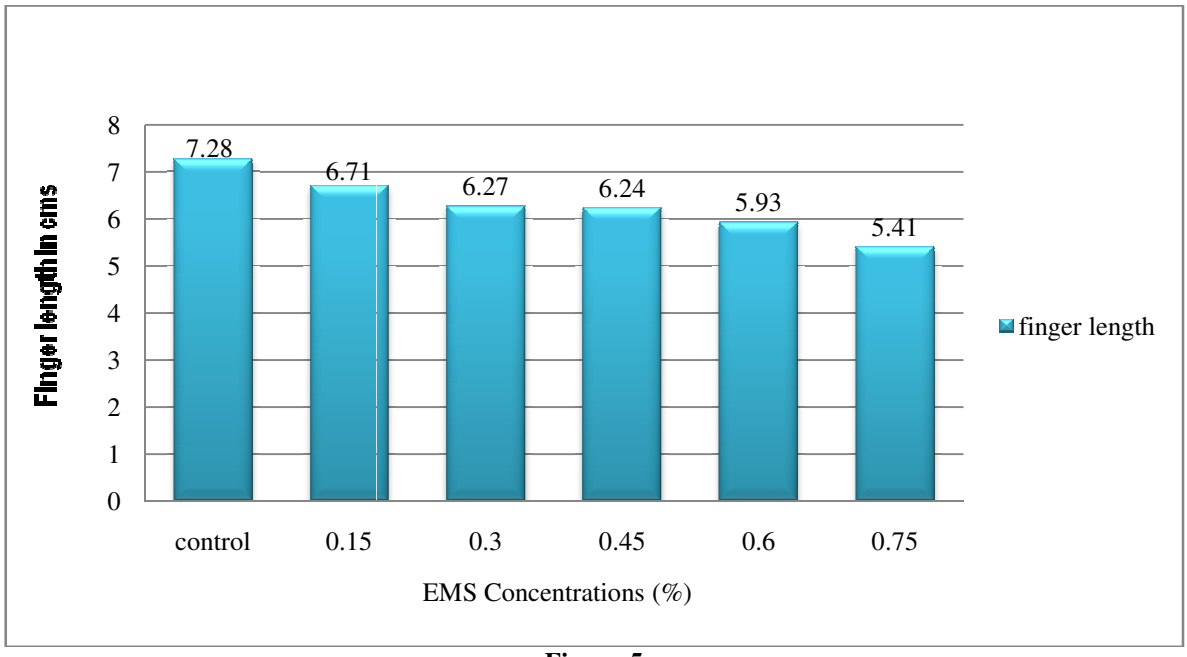

Figure-5
Treatment effect of mutagen on finger length

It could be seen that the maximum length of fingers (6.71 cm) was observed at the concentration of 0.15 %. EMS. When considering the length of fingers of control (7.28 cm), the different treatments showed a reduced length of fingers. The plants treated with 0.75% of EMS recorded the minimum length of fingers (5.41 cm)

Muduli and Misra[15] reported that the increase in doses of mutagen affects the length of finger millet crop and the length was gradually decreased. Earhead length and finger length had significant positive association with grain yield. These results are in conformation with the earlier report by Satish[16]. Maximum number of fingers (6.71) was observed in 0.15 % concentration of EMS, followed by 0.30%. A minimum number of fingers was 5.41, recorded in 0.75 % of EMS treated plants.

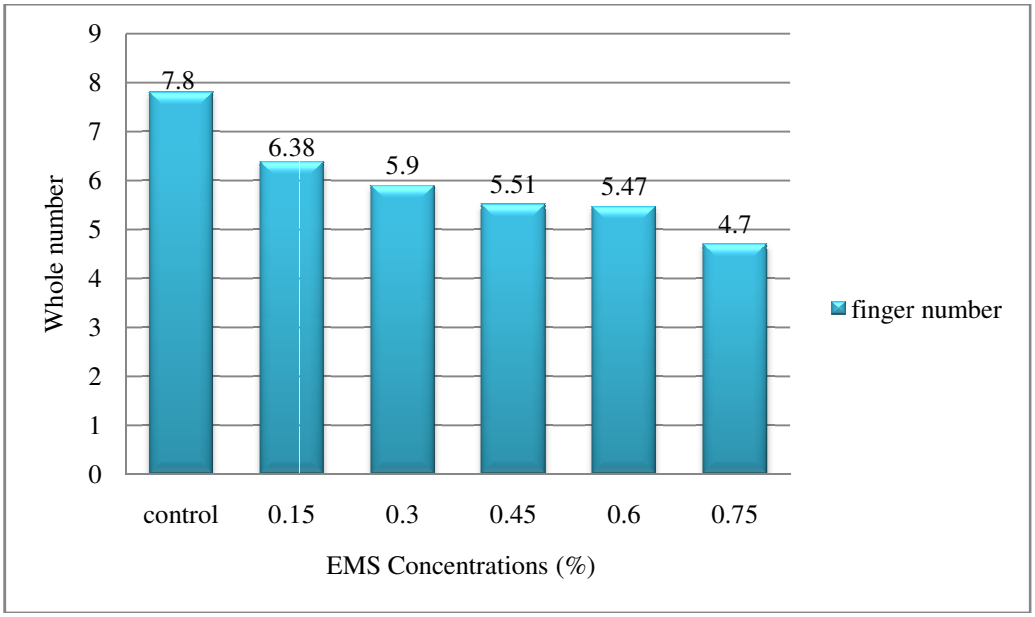

Figure-6
Treatment effect of mutagen on finger number

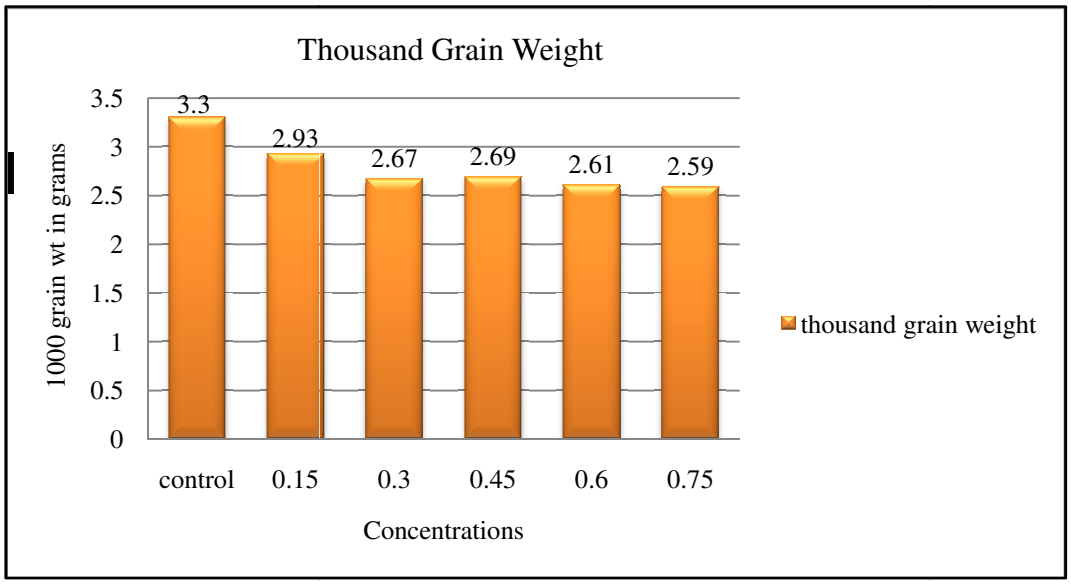

Figure-7
Treatment effect of mutagen on Thousand Grain Weight

1000 Grain Weight: The Thousand grain weight was observed for the control had got 3.30 grams. While treating with the seeds with EMS with different concentration, the grain weight were gradually decreases. As the concentration increase, the maximum 1000 grain weight was observed got from the plants, treated with the EMS of 0.15% as 2.9 grams. The minimum /lowest 1000 grain weight was observed in the seeds of plants treated with 0.75% of EMS.

Sankara Vadivoo et al[11] reported that the 1000 grain weight variability in the different concentration of EMS treatments and Gamma radiation treatment. Their experiment coincides with one experiments in the present study.

Maximum grain yield of 23.816 grams was observed in the plants germinated from the seeds which where treated with the EMS at the rate of 0.15%. The plants germinated from the seeds treated with 0.30% of EMS recorded 22g. The least measure in grain yield was observed in the plants germinated from the seeds which were treated with 0.75% of EMS .which recorded the grain yield of 21.05%.

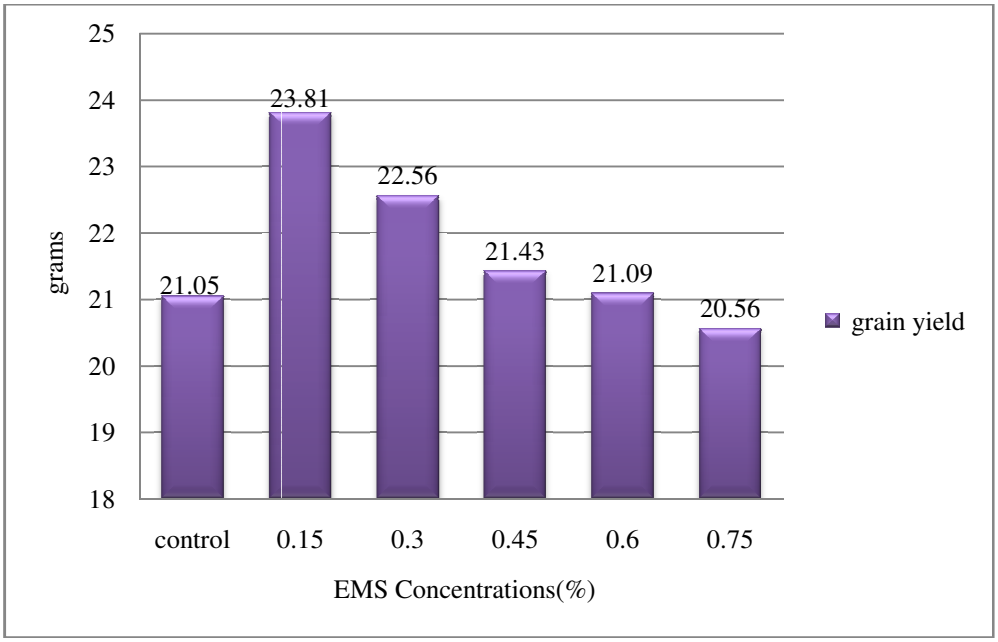

Figure-8
Treatment effect of mutagen on Grain Yield

Kadkol and Swaminathan[17] reported that the grain yield of plants germinated from the seeds treated with EMS and gamma rays were gradually decreases while the concentration increases. This study shows the effect of mutation treatment on grain yield.

Conclusion

In laboratory experiment germination percentage (90%), the maximum root length of 5.71 cm and shoot length of 3.86 cm on 13th day were observed in the treatment of 0.15% of EMS. The seedling length of 9.58 cm for 0.15% EMS treatment which showed the maximum length among all the treatments. In case of vigour index, maximum vigour index of 913.26 was recorded at 0.15% of EMS treatment. The minimum vigour index was observed in 0.75% of EMS treatment. In case of Stress tolerant index, 0.30% of EMS treatment recorded the maximum stress tolerant index of 114.89 than any other EMS treatments. By considering all these results, 0.15% of EMS treatment showed the desirable values to the said parameters than any other treatments.

In M_1 generation, 0.15% of EMS treated plants showed a early flowering among all other treatments. The maximum plant height, tillers per plant, productive tillers per plant, finger number, finger length, 1000 grain weight and gain yield were observed in 0.15% EMS concentration.

Hence, it was observed that 0.15% concentration showed the desirable values and these values were decreased with increasing concentration.

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