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Assessment of quantitative characters of groundnut *(Arachis hypogeae.*L) mutants in M3 Generation under Induced EMS Mutagenesis

A. Yugandhar[1], Kumara Joshi[1], K. Srinivas Naik[2], P. Sathish[3], and G. Vijay Kumar*[1]

[1]Department of Genetics, Osmania University, Hyderabad, India
[2]Centre for plant molecular Biology, Osmania University, Hyderabad, India
[3]ICAR- Central Research Institute for Dryland Agriculture, Hyderabad, India
yugandhar971@gmail.com; chin2josh@gmail.com; Srinivasnaik.cpmb@gmail.com; santhurainbow@gmail.com
*Corresponding author: vijay.genetics@gmail.com

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Abstract— *In the present study, three groundnut genotypes ICG2106, ICG5236 and ICG76 were collected from ICRISAT, Patancheru to study the mutagenic effect of EMS (Ethyl methane sulfonate) on the quantitative traits. The groundnut seeds were treated with different (0.3%, 0.4% and 0.5%) concentrations of chemical mutagen EMS and the seeds were sown in the experimental farm of department of genetics, Osmania University, Hyderabad. The ANOVA results revealed that the difference is highly significant due to the treatment of all the characters indicating that there is a considerable amount of genetic variability in the genotypes. In among the three genotypes (ICG2106, ICG5236 and ICG76), the quantitative traits were found to be higher in the genotype ICG2106 than ICG5236, ICG76 and it is also evident from the study that when the concentration of EMS increased, the mean values of all the quantitative traits decreased. It is observed that the seeds treated with 0.3% EMS and 0.4% EMS concentrations showed the highest mean values for quantitative characters under consideration. These mutant varieties can be further utilized in groundnut crop improvement programme.*

Keywords— ***Groundnut, Mutant genotypes, EMS mutagen, M3 generation, Yield parameters.***

I. INTRODUCTION

Fabaceae is the family that includes legumes. Plants belong to the *leguminosae* family produce edible dry seeds known as groundnut seeds. Groundnut is the major oil seed crop in India and it plays a major role in brining the vegetable oil deficit in the country. Groundnuts in India are available throughout the year due to a two crop cycle harvested in March and October. People and livestock alike rely heaving on legumes and pulses for their protein and amino acid needs. Cereals and legumes make up a large percentage of the human diet worldwide**.** Groundnut is the most important source of protein which helps to meet the nutritional requirements of the masses in the developing countries. Groundnut with some fat constitutes the balanced diet for the majority of the people in the world. As a source of protein and fiber, they highlight the benefits of groundnut and imply that these legumes amino acid profile complements that of lysine deficient in groundnut. Groundnut have a seed protein concentration of 26 – 30% making them 2-3 times more protein dense than cereals and pulses. Both globulins (60-80%) and albumins (10-25%) are abundant in groundnut (Yang *et al.*, 2021). It is the fourth most important source of vegetable protein. It contains 48-50% oil and 26-28% protein and is a rich source dietary fiber, minerals and vitamins (Prasad *et al.*, 2009). Groundnut production is decreasing gradually because of various biotic and abiotic stresses. Biotic stresses such as fungal, bacterial and viral diseases play a major role in yield reduction. The soil borne diseases caused by fungal pathogens are very important and several of them have the potential to cause significant yield losses in groundnut production (Ganesan and Sekar, 2012).Crop improvement requires genetic variability, and it has been discovered that induced mutation is a highly successful method for generating genetic variability in both quantitative and qualitative traits Geetha *et al*., (2024). Groundnut can be genetically enhanced by a variety of crop improvement techniques, including hybridization, selection, mutation, and more. Groundnut (*Arachis hypogeae* L.) has low genetic variety mainly because of its monophyletic descent from groundnut, its wild ancestor. Mutation has been regarded as a powerful tool for crop improvement and evolution among all the adopted breeding approaches. As one of the most often used alkylating agents, ethyl methane sulfonate (EMS) can introduce an active alkyl group that causes base alterations and nucleotide mutations, hence causing chemical modification of nucleotides mutations. EMS mostly causes alterations in guanine residue Boysen (1990). Nucleotide substitutions are induced with high frequency in chemical mutagenesis; in EMS-mutated populations, GC to AT base pair transitions account for 70-99% of the alterations. The variations in guanine are mostly caused by the EMS. Because the O^6- exhalation pair is more stable than the thymine pair in comparison to cytosine, the O^6- GC pair frequently transforms into an AT pair during replication. Numerous researches on the genotoxic activity of EMS in vivo and in vitro show unequivocally that EMS is a carcinogenic substance and should be used with extreme caution. Mutant populations have been created by the application of physical mutagens. On the other hand, greater DNA inversions and deletions caused by gamma radiation and rapid neutrons can make it more difficult to identify the genes responsible for a mutant phenotype. Alternatively, a chemical substance called EMS has been widely used to cause mutations in seeds. Random point mutations are frequently induced by EMS, and some of these mutations can result in the creation of unique stop codons in target genes Chen *et al*., (2023). In these cases, improving crop varieties with better-than average proteins, minerals, and large yields is the first step in salvaging the situation Rafiq (2014). When a good variety needs to be improved, mutation breeding is an additional benefit because it only needs to change one or two features. The mutagen dose ought to be strong enough to enhance the likelihood of triggering a mutation, but not so high as to harm cells or tissues to the point of fatality. To get good results in seed treatment, the dose known as LD 50 is typically utilized, which is adequate to block roughly 50% germination. Irradiated populations are typically produced at a dose below LD 50 and with an LD 50 dose therapy [10]. To create the greatest number of viable mutants with the least amount of plant harm, the LD50 value for each mutagen must be determined Handayani *et al.*, (2023). One of the traditional breeding techniques used in plant breeding is mutation breeding. It is pertinent to a number of disciplines, including molecular biology, biotechnology, morphology, and cytogenetic. Ethyl Methane Sulphonate (EMS) is an alkylating chemical that induces high frequency of base pair substitutions and is a well-potential mutagen that is frequently used to produce genetic diversity Shinde, and Sagade, (2016). In groundnut, Seeds are the edible part that can be eaten which is a great source of nutrients, carbohydrates and protein for vegetarians in particular.

II. MATERIALS AND METHODS

Three groundnut varieties (ICG2106, ICG5236 and ICG76) were obtained from ICRISAT, Patancheru. Fifty healthy and uniform seeds were selected and initially soaked in water for nearly 4-6 hours then cleaned with tissue paper and dried. Different concentrations of EMS mutagen are prepared to start from 0.3%, 0.4% and 0.5% as per mutagenesis protocol. Fifty seeds each were soaked in each concentration of EMS mutagen for 6 hours in a rotary shaker at 180 rpm at 27±1°C of room temperature. For the effective and uniform absorption of EMS, the volume of EMS solution should be 10 times the proportion of seed volume. Untreated Fifty seeds were used as the control. Untreated seeds and EMS-treated seeds were sown in the field in an RBD (Randomized Block Design) with three replications each. Quantitative characters under consideration were studied in the M2 generation. The genotypes showing the highest quantitative characters in the M2 generation were selected and sown to get the M3 generation. In M3 generation, different yield parameters were studied.

III. RESULTS AND DISCUSSIONS

The ANOVA results revealed that the difference in the means of different parameters were highly significant due to the treatment of all the characters indicating there is ample genetic variability in the genotypes.

Table-1: Quantitative traits of groundnut mutants were analyzed using an analysis of variance (ANOVA) in EMS mutagenesis.

Source of variations	DF	MSSQ							
		Characters							
		Pl. Ht (cm)	Bran/pl	Lea/pl	Flow-Ini	Pods/pl	Pod. Wt (g/pl)	Seeds/pl	Seed.Wt (g/pl)
Replications	49	149.000	162.358	71.640	96.000	60.273	51.202	23.793	29.793
Treatments	11	625.121	966.921	11,957.880	225.712	7,823.698	12,225.911	24,370.651	6,520.674
Error		0.987	0.817	1.832	0.878	0.765	0.694	0.683	0.726
St E		0.141	0.128	0.191	0.132	0.124	0.118	0.117	0.120
SD		0.199	0.181	0.271	0.187	0.175	0.167	0.165	0.170
CV (%)		2.727	5.208	1.722	4.486	1.872	1.397	1.036	2.047

**Significant at 0.05% and ** at 0.01 % level, respectively*

Pl.ht- Plant height (cm), Bran/pl- Number of branches per plant, Lea/pl- Number of leaves per plant, Flow-ini- Days to flower initiation, Pods/Pl- Number of pods per plant, Pod.Wt (g/Pl)- Pod weight per plant (g), Seeds/Pl- Number of seeds per plant, Seed.Wt (g/Pl)- Seed weight per plant (g).

Table- 2: Effects of EMS on various biological parameters in M3 generation of groundnut

Genotypes	Characters	Pl.ht (cm)	Bran/pl	Lea/pl	Flow.ini	Pods/pl	Pod.Wt (g/pl)	Seeds/Pl	Seed.Wt (g/pl)
ICG2106	Control	30.00	10.60	53.62	24.10	31.70	41.10	53.20	28.40
	0.3% EMS	39.50	21.50	91.50	18.60	69.10	88.76	118.90	62.70
	0.4% EMS	38.20	19.10	88.10	19.60	55.90	71.60	97.20	50.76
	0.5% EMS	36.70	17.80	84.30	20.50	46.30	58.90	80.90	41.90
ICG5236	Control	30.80	10.57	53.35	24.30	29.50	37.50	48.12	25.50
	0.3% EMS	39.10	21.90	90.60	18.70	55.30	67.70	94.70	49.70
	0.4% EMS	38.70	19.70	86.50	19.70	47.72	59.70	82.10	42.80
	0.5% EMS	37.20	18.30	83.40	20.50	40.26	51.10	67.50	35.02
ICG76	Control	31.60	10.04	53.11	24.20	30.40	40.00	50.10	26.50
	0.3% EMS	39.60	21.30	89.90	19.20	60.62	75.90	101.20	52.10
	0.4% EMS	38.70	19.30	86.10	20.20	51.38	67.48	88.40	45.38
	0.5% EMS	37.10	18.20	82.70	21.00	42.70	55.80	74.80	38.60

Pl. ht- Plant height (cm), Bran/pl- Number of branches per plant, Lea/pl- Number of leaves per plant, Flow-ini- Days to flower initiation, Pods/Pl- Number of pods per plant, Pod.Wt (g/Pl)- pod weight per plant (g), Seeds/Pl- Number of seeds per plant, Seed.Wt (g/Pl)- seed weight per plant (g).

The table displays the average plant height (cm) for our population. ICG76 at 0.3% EMS had the highest plant height (cm), measuring 39.60 (cm), while ICG2106 at control had the lowest measuring 30.00 (cm). The genotype ICG2106 had the tallest plants, measuring 39.50 (cm) for 0.3% EMS, 38.20 (cm) for 0.4% EMS, 36.70 (cm) for 0.5% EMS, and 30.00 (cm) for the control. The highest plant height for the genotype ICG5236 was recorded by 0.3% EMS at 39.10 (cm), followed by 0.4% EMS at 38.70 (cm), 0.5% EMS at 37.20 (cm), and control at 30.80 (cm). The character plant height for the genotype ICG76 was 39.60 (cm) in 0.3% EMS, which was followed by 38.70 (cm) in 0.4% EMS, 37.10 (cm) in 0.5% EMS and 31.60 (cm) in control, respectively. The table displays the mean performance of the number of branches per plant in our population. ICG5236 at 0.3% EMS had the most branches per plant, with 21.90, while ICG76 at control had the fewest, with 10.04. The genotype ICG2106 had the most branches per plant with 0.3% EMS (21.50%) followed by 0.4% EMS (19.10%), 0.5% EMS (17.80%) and control (10.60%). The highest number of branches per plant for genotype ICG5236 was recorded by 0.3% EMS with (21.90) followed by 0.4% EMS with (19.70), 0.5% EMS with (18.30), and control with (10.57). The highest character number of branches per plant for the genotype ICG76 was found in 0.3% EMS with (21.30) followed by 0.4% EMS with (19.30), 0.5% EMS with (18.20) and control with (10.04) respectively. The table displays the mean performance of the number of leaves per plant in our population. ICG2106 at 0.3% EMS had the most leaves per plant 91.40, while ICG76 at control had the fewest leaves per plant 53.11. With 91.50 leaves per plant, the genotype ICG2106 had the most leaves per plant, followed by 0.4% EMS with 88.10, 0.5% EMS with 84.30, and control with 53.62. The highest number of leaves per plant for genotype ICG5236 was recorded by 0.3% EMS with 90.60, followed by 0.4% EMS with 86.50, 0.5% EMS with 83.40, and control with 53.35. The highest character number of leaves per plant for the genotype ICG76 was found in 0.3% EMS with 89.90 followed by 0.4% EMS with 86.10, 0.5% EMS with 82.70 and control with 53.11 respectively. The ICG2106 genotype in 0.3% EMS showed an early flower initiation time of 18.60 days, while the ICG5236 genotype in control showed a late flowering time of 24.30 days. In 0.3% of EMS, the genotype ICG2106 showed early flower initiation at 18.60 days, followed by 0.4% at 19.60 days, 0.5% at 20.50 days, and the control at 24.10 days. In 0.3% of EMS, the genotype ICG5236 showed early flower initiation at 18.70 days, followed by 0.4% at 19.70 days, 0.5% at 20.50 days, and the control at 24.30 days. For the genotype ICG76 was recorded highest early flower initiation was observed in 0.3% EMS with19.20 days, 0.4% EMS with 20.20 days, 0.5% EMS with21.00 days, and control with 53.11 respectively. The average number of pods per plant in our population is displayed in the table; ICG2106 at 0.3% EMS had the most pods per plant (69.10), while ICG5236 at control had the fewest (29.50). The genotype ICG2106 produced the most pods per plant (69.10) at 0.3% EMS, followed by 0.4% EMS (55.90), 0.5% EMS (46.30), and control (31.70). The highest number of pods per plant for genotype ICG5236 was recorded by 0.3% EMS with 55.30, followed by 0.4% EMS with 47.72, 0.5% EMS with 40.26, and control with 29.50. The highest character number of pods per plant for the genotype ICG76 was found in 0.3% EMS with 60.62 followed by 0.4% EMS with 51.38, 0.5% EMS with 42.70 and control with 30.40 respectively. The average pod weight (g) per plant for our population is displayed in the table. ICG2106 at 0.3% EMS had the highest pod weight (g) per plant, measuring 88.76 (g), while ICG5236 at control had the lowest pod weight (g), measuring 37.50 (g). The highest pod weight per plant was recorded by the genotype ICG2106 by 0.3% EMS (88.76 g), 0.4% EMS (71.60 g), 0.5% EMS (58.90 g), and control (41.10 g), in that order. The highest pod weight per plant for genotype ICG5236 was recorded by 0.3% EMS at 67.70 (g), followed by 0.4% EMS at 59.70 (g), 0.5% EMS at 51.10 (g), and control at 37.50 (g). The character pod weight per plant for the genotype ICG76 was recorded highest in 0.3% EMS with 75.90 (g) followed by 0.4% EMS with 67.48 (g), 0.5% EMS with 55.80 (g) and control with 40.00 (g), respectively. The average performance of the number of seeds per plant in our population is displayed in the table. ICG2106 at 0.3% EMS had the most seeds per plant (118.90), while ICG5236 at control had the fewest (48.12). In the genotype ICG2106, 0.3% EMS produced the most seeds per plant (118.90), followed by 0.4% EMS (97.20), 0.5% EMS (80.90), and control (52.30). The highest number of seeds per plant for genotype ICG5236 was recorded by 0.3% EMS (94.70), followed by 0.4% EMS (82.10), 0.5% EMS (67.50), and control (48.12). The highest character number of seeds per plant for the genotype ICG76 was found in 0.3% EMS with 101.20 followed by 0.4% EMS with 88.40, 0.5% EMS with 74.80 and control with 50.10, respectively. The average seed weight (g) per plant for our population is displayed in the table. ICG2106 at 0.3% EMS had the highest seed weight (g) per plant, measuring 62.70 (g), while ICG5236 at control had the lowest, measuring 25.50 (g). The highest seed weight per plant was recorded by the genotype ICG2106 by 0.3% EMS (62.70 g), followed by 0.4% EMS (50.76 g), 0.5% EMS (41.90 g), and control (28.40 g). The highest seed weight per plant for genotype ICG5236 was recorded by 0.3% EMS at 49.70 (g), followed by 0.4% EMS at 42.80 (g), 0.5% EMS at 35.02 (g), and control at 125.50 (g). The characteristic seed weight per plant for the genotype ICG76 recorded highest in 0.3% EMS with 52.10 (g) followed by 0.4% EMS with 45.38 (g), 0.5% EMS with 38.60 (g) and control with 26.50 (g), respectively.

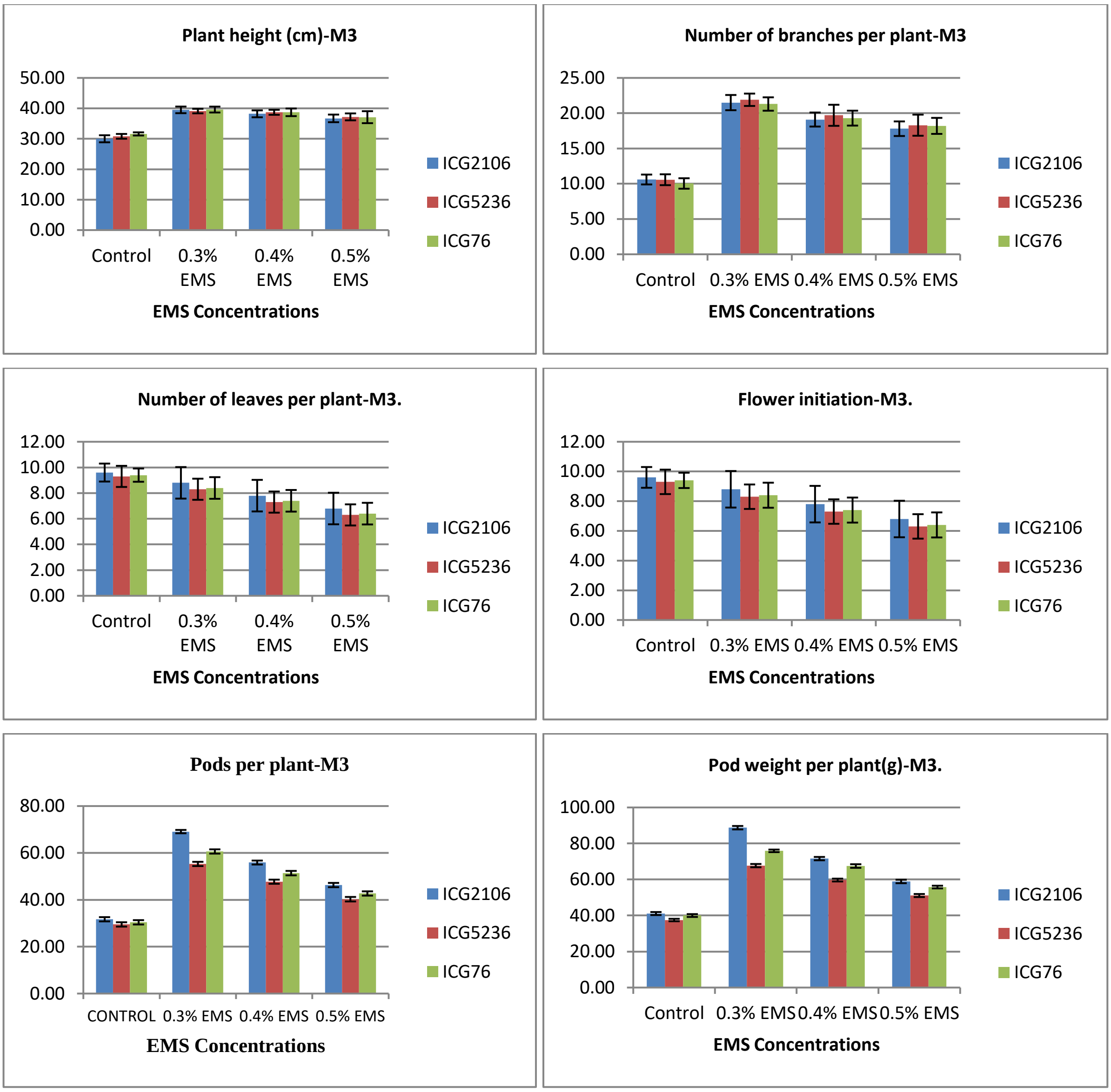
Table-3: Mean performance and % increased/decreased over control (untreated) for ten quantitative characters of groundnut in M3 generation

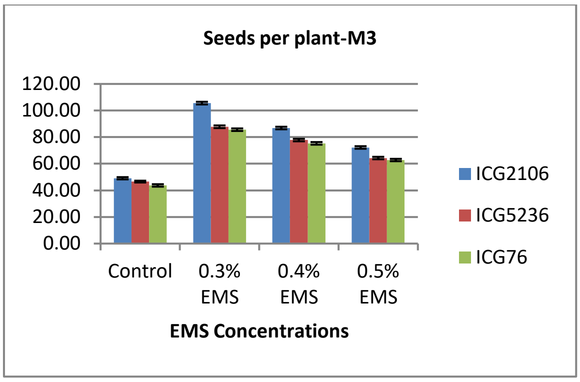
Genotypes	Characters	Pl.ht (cm)	Bran/pl	Lea/pl	Flo.ini	Pods/pl	Pod.Wt (g/pl)	Seeds/Pl	Seed.Wt (g/pl)
ICG2106	0.3% EMS	24.05	50.70	41.40	-29.57	54.12	53.70	55.26	54.70
	0.4% EMS	21.47	44.50	39.14	-22.96	43.29	42.60	45.27	44.05
	0.5% EMS	18.26	40.45	36.39	-17.56	31.53	30.22	34.24	32.22
ICG5236	0.3% EMS	21.23	51.74	41.12	-29.95	46.65	44.61	49.19	48.69
	0.4% EMS	20.41	46.35	38.33	-23.35	38.18	37.19	41.39	40.42
	0.5% EMS	17.20	42.25	36.04	-18.54	26.73	26.61	28.71	27.18
ICG76	0.3% EMS	20.20	52.86	40.92	-26.04	49.85	47.30	50.49	49.14
	0.4% EMS	18.35	47.98	38.31	-19.80	40.83	40.72	43.33	41.60
	0.5% EMS	14.82	44.84	35.78	-15.24	28.81	28.32	33.02	31.35

Pl.ht- Plant height (cm), Bran/pl- Number of branches per plant, Lea/pl- Number of leaves per plant, Flow-ini- Days to flower initiation, Pods/Pl- Number of pods per plant, Pod.Wt (g/Pl)- Pod weight per plant (g), Seeds/Pl- Number of seeds per plant, Seed.Wt (g/Pl)- Seed weight per plant (g).

The table displays the genotype ICG2106 grown under 0.5% EMS, the trait plant height (cm) decreased the most at 18.26 (cm) and the least at 0.3% EMS by 24.05 (cm) over control. For the genotype ICG5236, the greatest reduction was found at 0.5% EMS at 17.20 (cm) and the lowest at 0.3% EMS at 21.23 (cm) over control. In contrast, ICG76 showed the greatest reduction in character plant height at 0.5% EMS by 14.82 (cm) and the lowest reduction at 0.3% EMS by 20.20 (cm), which was its control. The findings showed that, in comparison to the control, plant height was significantly decreased under EMS-induced conditions at higher EMS concentrations. The same outcome an increase and decrease in plant height (cm) under EMS-induced conditions. The induced mutagenesis of both the varieties of groundnut shows several mutants affecting plant height in M3 generation. 22 tall and 19 dwarf mutants were found in M3 generation of variety AK-159, the plant height was increased by 53.84 per cent and decreased by 28.20 per cent respectively. 18 Tall and 11 dwarf mutants were recorded form variety TAG-24. From the whole population it is concluded that chemical mutagen i.e. EMS concentration 0.10 per cent in both varieties, TAG-24 and AK-159 are more effective in increasing plant height reported by Dwivedi *et al*., (1996). For the genotype ICG2106 grown under 0.5% EMS, the trait number of branches per plant decreased the most at 40.45 and the least at 0.3% EMS by 50.70 over control. For the genotype ICG5236, the highest reduction was found at 0.5% EMS 42.25 and the lowest at 0.3% EMS by 51.74 over control. On the other hand, ICG76 showed the greatest decrease in character plant height at 0.5% EMS by 44.84 and the lowest reduction at 0.3% EMS by 52.86 its control. The findings showed that, in comparison to the control, the number of branches per plant under EMS-induced conditions was significantly decreased at higher EMS concentrations. Earlier reported the same outcome, which was an increase and decrease in the number of branches per plant under EMS-induced conditions. Mutants were detected by visual observation of the plants during the whole plant growing cycle in each generation. Upadhyaya (2003) examined the ICRISAT core collection of 1704 accessions consisting of 794 subsp. *hypogaea* and 910 belonging to subsp. *fastigiata* for mean number of branches and observed them as 5.5 and 4.2, respectively. Further, Swamy *et al*. (2003) evaluated 504 accessions of which 230 belonging to subsp. *Hypogaea* and 274 to subsp. *fastigiata* and obtained mean number of branches of 2.8 to 3.5 and 1.6 to 3.1, respectively in four different growing seasons. For the genotype ICG2106 grown under 0.5% EMS, the trait number of leaves per plant decreased the most at 36.39 and the least at 0.3% EMS by 41.40 over control. For the genotype ICG5236, the highest reduction was found at 0.5% EMS at 36.04 and the lowest at 0.3% EMS at 41.12 over control. On the other hand, ICG76 showed the greatest decrease in character plant height at 0.5% EMS by 35.78 and the lowest reduction at 0.3% EMS by 40.92 its control. The findings showed that, in comparison to the control, the number of leaves per plant under EMS-induced conditions was significantly decreased at higher EMS concentrations. The same outcome which was an increase and decrease in the number of leaves per plant under EMS induced conditions. Mutants were detected by visual observation of the plants during the whole plant growing cycle in each generation. Visual phenotypic variation in growth performance and leaf morphology were recorded and photographs were taken to document the comparison between mutants and their control. The number of leaves per plant was recorded in positive shift at all treatment. Higher number of leaves was the lower number of leaves was observed in 0.1% of EMS concentration (43.26) when compared to control (48.63). Silva and Barbosa (1996) observed reduced leaf size, small and elongated leaflets and leaflets with folded margins in Milinionario-1732 variety of French bean after SA treatments in M3 generation. The genotype ICG2106 exhibited the greatest reduction in trait days to flower initiation at 0.3% EMS (-29.57), with the lowest reduction at 0.5% EMS (-17.56) compared to the control. Similarly, the genotype ICG5236 showed the highest reduction at 0.3% EMS (-29.95), with the lowest reduction at 0.5% EMS (-18.54) compared to the control. On the other hand, ICG76 showed the greatest decrease in character plant height at 0.3% EMS by -26.04 and the lowest reduction at 0.5% EMS by -15.24 its control. When compared to its control, the results showed that days to flower initiation were significantly shortened under EMS-induced conditions at lower EMS concentrations. The same outcome a decrease in the number of days until flower initiation under EMS-induced conditions was previously documented. Mutants were detected by visual observation of the plants during the whole plant growing cycle in each generation. The traits for the days to the first flowering contributed mostly to genetic diversity of the collection with a large range of variation because of the different responses of each genotype to the growing environment. Flowering traits are an important component for early maturity Upadhyaya and Nigam (1994) and likely for early harvest. Furthermore, Nigam and Aruna (2008) indicated that short plant stature, fewer days to the first flowering, and accumulation of the maximum numbers of early flowers are important traits to develop short duration groundnut cultivars. For the genotype ICG2106 grown under 0.5% EMS, the trait number of pods per plant decreased the most at 31.53 and the least at 0.3% EMS by 54.12 over control. For the genotype ICG5236, the highest reduction was found at 0.5% EMS 26.73 and the lowest at 0.3% EMS by 46.65 over control. In contrast, ICG76 showed the greatest decrease in character plant height at 0.5% EMS by 28.81 and the lowest reduction at 0.3% EMS by 49.85, which was its control. The findings showed that, in comparison to the control, the number of pods per plant under EMS-induced conditions was significantly decreased at higher EMS concentrations. The same outcome which was an increase and decrease in the number of pods per plant under EMS induced conditions. Mutants were detected by visual observation of the plants during the whole plant growing cycle in each generation. The genotypes having higher number of pods per plant offer an opportunity for improving seed yield in groundnut Nath and Alam (2002); Awal and Ikeda (2003). In the present investigation, number of pods per plant indicated positive correlation with seed yield. For the genotype ICG2106 grown under 0.5% EMS, the trait pod weight (g) per plant decreased the most at 30.22 (g) and the least at 0.3% EMS by 353.70 (g) over control. For the genotype ICG5236, the greatest reduction was found at 0.5% EMS at 26.61 (g) and the lowest at 0.3% EMS at 44.61 (g) over control. In contrast, ICG76 showed the greatest reduction in character plant height at 0.5% EMS by 28.32 (g) and the lowest reduction at 0.3% EMS by 47.30 (g) compared to its control. The findings showed that, in comparison to the control, pod weight (g) per plant under EMS-induced conditions decreased significantly at higher EMS concentrations. The decrease in pod weight (g) per plant under EMS-induced conditions had the same effect. The same outcome which was an increase and decrease in the pod weight (g) per plant under EMS induced conditions. Mutants were detected by visual observation of the plants during the whole plant growing cycle in each generation. Pod yield per plant of the study was similar as reported by previous studies of Ramakrishna *et al*. (2017). The shelling percentage had a non significant but positive association with pod weight. Mutagenic treatments affected the weight of the pods per plant. Thus, in the case of ethyl methane sulfonate at concentration of 0.2% (3.03) and 0.4% (3.65), the differences from the control sample were positive, very significant. Kadam *et al*. (2000) reported that pod weight (g) and haulm yield of groundnut significantly increased with application 10-tonne FYM ha-1. For the genotype ICG2106 grown under 0.5% EMS, the trait number of seeds per plant decreased the most at 34.24 and the least at 0.3% EMS by 55.26 over control. For the genotype ICG5236, the highest reduction was found at 0.5% EMS by 28.71 and the lowest at 0.3% EMS by 49.19 over control. On the other hand, ICG76 showed the greatest decrease in character plant height at 0.5% EMS by 33.02 and the lowest reduction at 0.3% EMS by 50.49 its control. The findings showed that, in comparison to the control, the number of seeds per plant was significantly decreased under EMS-induced conditions at higher EMS concentrations. Earlier reported the same outcome, which was an increase and decrease in the number of seeds per plant under EMS-induced conditions. Mutants were detected by visual observation of the plants during the whole plant growing cycle in each generation. The findings demonstrated that gen.p.360 and gen.p.302 displayed greater levels of these traits of M2 and M3 generations in T2 mutant plants, compared to control plants. But, these traits were compared in Giza 6 the mean values in T2 mutated plants were lower T1 compared to control in number of seeds per plant. The present study is in coherence with Manal *et al.* (2009) and Ali *et al.* (2010). For the genotype ICG2106 grown under 0.5% EMS, the trait seed weight (g) per plant decreased the most at 32.22 (g) and the least at 0.3% EMS by 54.70 (g) over control. For the genotype ICG5236, the greatest reduction was found at 0.5% EMS at 27.18 (g) and the lowest at 0.3% EMS at 48.69 (g) over control. In contrast, ICG76 showed the greatest reduction in character plant height at 0.5% EMS by 31.35 (g) and the lowest reduction at 0.3% EMS by 49.14 (g) compared to its control. The findings showed that, in comparison to the control, the seed weight (g) per plant under EMS-induced conditions decreased significantly at higher EMS concentrations. The decrease in seed weight (g) per plant under EMS-induced conditions had the same effect. The same outcome which was an increase and decrease in the seed weight (g) per plant under EMS induced conditions. Mutants were detected by visual observation of the plants during the whole plant growing cycle in each generation. The trait also plays an important role for seed yield Rehman *et al.* (2001); Kumar *et al.* (2010) and showed significant differences among genotypes and subspecies in the groundnut collection evaluated.

Fig: The graphical representation of quantative traits in groundnut mutants of M3 generation





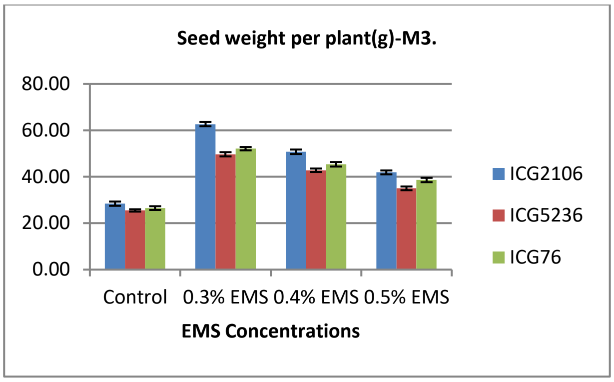


Fig: Photographical representation of quantative traits in groundnut mutants of M3 generation

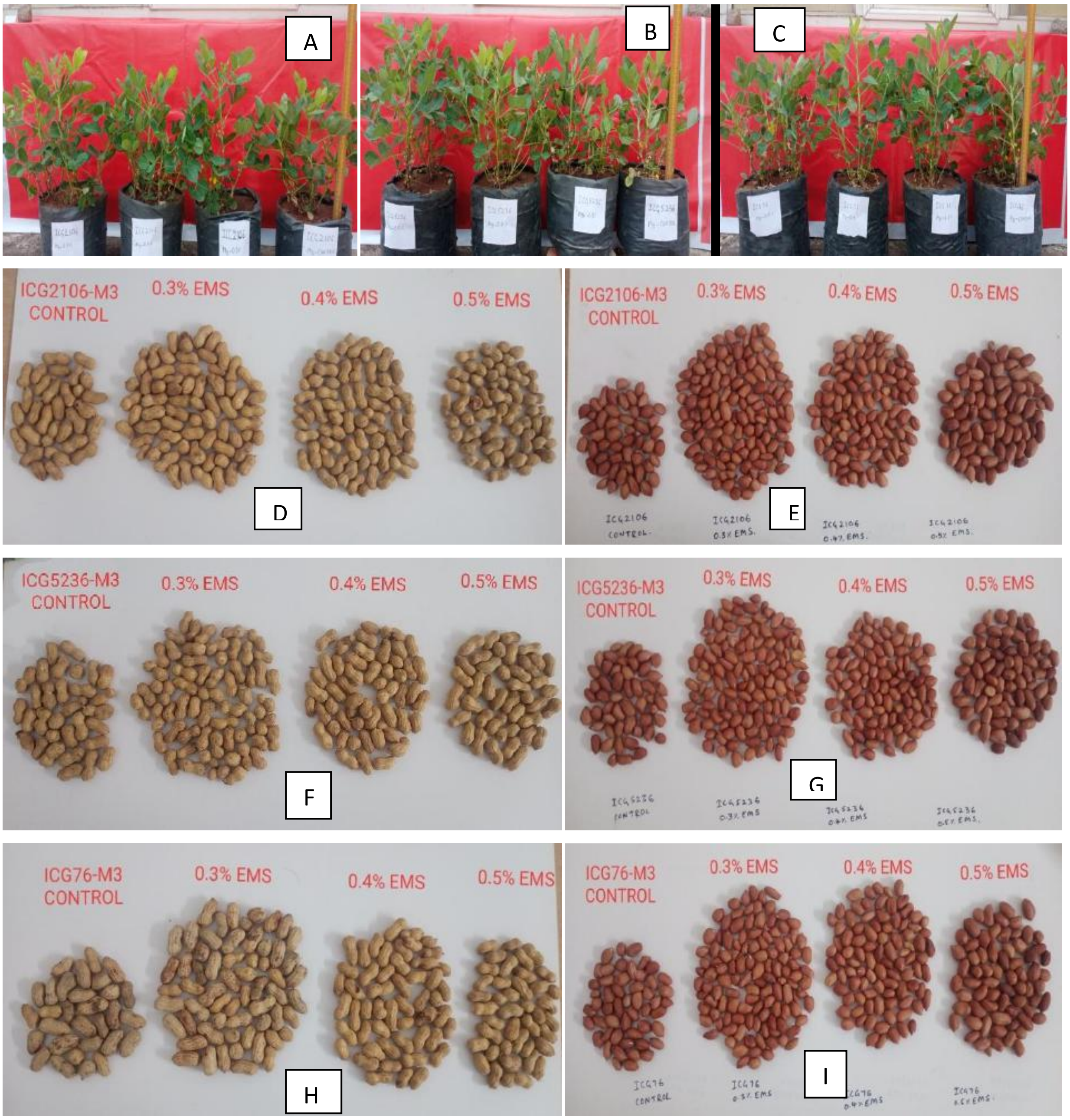


Fig: (A). Observations of groundnut plants - ICG2106. (B). Observations of groundnut plants - ICG5236. (C). Observations of groundnut plants – ICG76 in M3 generation.

D, F, H- Number of pods per plant and E, G, I- Number of seeds per plant

IV. CONCLUSION

This study explored the effect of Ethyl Methane sulfonate (EMS) on the yield of groundnuts across three genotypes (ICG2106, ICG5236, and ICG76) in M3 generation. EMS-induced mutants showed significant variation in phenotypic traits such as plant height, number of branches, number of leaves, and yield in the M3 generation. The results revealed that increasing EMS concentration generally led to a decline in yield across all three genotypes in M3 generation. In the M3 generation, found with the 0.3% EMS-treated ICG2106 mutant, which yielded significantly more (62.70 gm) than its control (28.40 gm) followed by 0.4% (50.76 gm) and 0.5% (41.90 gm). This increase in yield was primarily attributed to a higher number of pods, pod weight, and seed number. These findings suggest that EMS mutagenesis can induce beneficial genetic changes, especially in the ICG2106 genotype treated with 0.3% EMS. This mutant could serve as a valuable resource for groundnut breeding programs, offering potential for improving yield-related traits.

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REFERENCES

[1] Ali, H., T. M. Shah, N. Iqbal, B. M. Atta and M. A. Haq (2010). Mutagenic induction of double podding trait in deferent genotypes of chick pea and their characterization by STMS marker. *Plant Breeding*. 129: 116-119.

[2] Awal, M.A, Ikeda, T. (2003). Controlling canopy formation, flowering, and yield in field-grown stands of peanut (*Arachis hypogaea* L.) with ambient and regulated soil temperature. *Field Crops Research*, 81: 121–132.

[3] Dwivedi, S.L., singh, A.K. and Nigam, S.N. (1996). Unstable white flower color in groundnut (*Arachis hypogeae* L.). Journal of heredity, 87: 247248.

[4] G. Boysen, B.F. Pachkowski, J. Nakamura and J.A. Swenberg. (2009).The formation and biological significance of N7- guanine adducts. Mutation research- Genetic Toxicology and Environmental mutagen, 678: 76-94.

[5] Ganesan, S., Sekar, R. (2012). Fluorescent Pseudomonas as plant growth promoting rhizobacteria and biocontrol agents in groundnut crop (*Arachis hypogeae*.L). *International journal of applied biosciences.* 12, 1-6.

[6] K. Geetha, S. Divya and S. Srividya. (2024). "Studies on effect of mutagens on quantitative characters in M2 and M3generation of Horse gram [*Macrotyloma uniflorum* (Lam.) verdic]", Legume research- An International Journal, 47: 176-182.

[7] Kadam, U.A., Pawar, V.S., Pradeshi, H.P. (2000). Influence of planting layouts, organic and levels of sulpher on growth and yield of summer groundnut. Journal of Maharashtra Agriculture University. 25(2):211-213.

[8] Kumar, S.I., Govindaraj, M., Kumar, V.K. (2010). Estimation of genetic diversity of new advanced breeding lines of groundnut (*Arachis hypogaea* L.). *World Journal of Agricultural Science*, 6: 547–554.

[9] L. Chen. (2023). Current trends and insights on EMS mutagenesis application to studies on plant abiotic stress tolerance and development. Frontries in plant science, 13: 1-9.

[10] M. Rafiq wani. (2014). Mutation breeding: A novel technique for genetic improvement of pulse crops particularly chick pea (*Cicer arietinum* L) in improvement of crops in the Era of climatic changes. Springer New York, 217-248.

[11] Manal Eid, S., Griesh, A., Gruigis and Abdelmageed, A.M. (2009). Induction of genetic variability for quantitative traits and oil content in groundnut (*Arachis hypogeae* L) by using gamma rays and Acriflavin mutagens. Agricultural research of journal. Suez Canal university, 9 (2): 1-8.

[12] Nath, U.K., Alam, M.S. (2002). Genetic variability, heritability and genetic advance of yield and related traits of groundnut (*Arachis hypogaea* L.). *Journal of Biological Sciences*, 2: 762–764.

[13] Nigam, S.N, Aruna, R. (2008). Improving breeding efficiency for early maturity in peanut. *Plant Breeding Reviews*, 30, 295–322.

[14] P. Shinde and A.B. Sagade. (2016). Agriculture and technology effect of ethyl methane sulphonate (EMS) on seed germination and seedling injury in chick pea (*Cicer arietinum* L). International journal of researches in biosciences, 9: 11-18.

[15] Prasad, P.V., Kakani, V.G., Upadhyaya H.D. (2009). "Growth and production of groundnut", in soils, plant growth and Crop production. Ed. Verheye W.H. (Oxford, UK: Eolss Publishers ;), 138-167.

[16] Ramakrishnan, P., Manivannan, N., Mothilal, A and Mahalingam, L. (2017). Correlation studies in backcross derived population for foliar disease resistance in groundnut (*Arachis hypogaea* L.).

International Journal of Current Microbiology and Applied Sciences, 6(5): 266-272.

[17] Rehman, A.U., Wells, R., Isleib, T.G. (2001). Reproductive allocation on branches of virginia-type peanut cultivars bred for yield in North Carolina. *Crop Science*, 41: 72–77.

[18] S. Handayani, N., M.S.A Harahap, G. Irawan (2023). Determination of lethal dose 50 for induced mutagenesis in soybean [Glycene max (L.) Merril] CV. Gepak kuning through Ethyl methane sulfonate mutagen. Agricultural science Digest- a research journal. 544.

[19] Silva, E. G. and Barbosa, H. M. (1996). Mutagenecity of sodium azide in French bean (Phaseolus vulgaris L). *Brazilian Journal of Genetics.* 19 (2): 319-322.

[20] Swamy, B.P.M., Upadhyaya, H.D., Goudar, P.V.K., Kullaiswamy, B.Y., Singh, S. (2003). Phenotypic variation for agronomic characteristics in a groundnut core collection for Asia. *Field Crops Research*, 84: 359–371.

[21] Upadhyaya H D, Nigam S N. (1994). Inheritance of two components of early maturity in groundnut (*Arachis hypogaea* L.). *Euphytica*, 78, 59–67.

[22] Upadhyaya, H.D., Ortiz, R., Bramel, P.J., Singh, S. (2003). Development of a groundnut core collection using taxonomical, geographical and morphological descriptors. *Genetic Resources and Crop Evolution*, 50, 139–148.

[23] Yang, Y., He, S., Zhang, Y., Li, X., Liu, H., Li, Q. (2021). Comparison of crude prolamins from seven kidney beans (*Phaseolus vulgaris*.L) based on composition, structure and functionality. *Food chemistry*. 357: 129-748.