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EFFECTS OF PARA-DICHLOROBENZENE AND SODIUM AZIDE ON GROWTH AND YIELD OF SESAME (*Sesamum indicum* L.)

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ABSTRACT
Sesame is an important source of income and edible oil particularly in sub-saharan Africa. Its cultivation is constrains by many factors including lack of improved varieties. This research was carried out to evaluate the effect of chemical mutagens (Sodium Azide and Para-dichlorobenzene) on Germination and Seedlings of three sesame varieties (Ex-sudan, E-8 and JAN-IRI). Pot experiments were conducted during 2017and 2018 dry seasons using completely randomized design (CRD). The treated seeds were planted and resulting plants (M_0) were allowed to produce the seeds. The seeds of the M_0 were used in generating M_1 plant which were used to evaluate the effect of the mutagens. The seeds of M_0 were planted in a polypots containing (3:1 top soil and compost manure mixture) and watered every two days. Few days to germination were obtained in seed treated with 1.0 mM Sodium azide (3.0 days) and 3.0 mM Para-dichlorobenzene (3.0 days) in Ex-Sudan, 3.0 mM Sodium azide (3.0 days) in E-8 while the highest root length at seedling stage was obtained when JAN-IRI and Ex-sudan were treated with 1.0 mM Para-dichlorobenzene (4.2cm) and the highest shoot length was obtained when Ex-sudan was treated with 2.0 mM (19.3cm) and 3.0 mM Sodium azide (18.2cm). Therefore, it is recommended that application of Sodium azide at 2.0 mM and 3.0 mM Para-dichlorobenzene should be adopted by breeders in improving quantitative and physiological traits of sesame varieties.

Keywords*:* Sesame, Mutagen, Germination, Para-dichlorobenzene, Chlorophyll

INTRODUCTION

The Sesame (*Sesamum indicum* L.) belongs to the Pedaliaceae family is one of the most ancient oil seed known to mankind and plays a major role in human nutrition (komivi *et al.,* 2017). It is called Queen of oil seed due to its high quality poly unsaturated stable fatty acid which restrains oxidative rancidity (Reddy, 2006). Sesame is widely grown by small-holder farmers in Northern and Central part of Nigeria. It is a major cash earner in many northern state such as Nasarawa, Jigawa, Kano, Katsina, Plateau and Yobe state and in Abuja, the Federal Capital Territory of Nigeria (NAERLS, 2010). The world harvested 4.8 million metric tons of sesame seeds in 2017, with India and China as the largest producers. About 6.6 million hectares of the total world crop area are under sesame cultivation (Riley, 2000), with Africa ranking second with 25% of the total hectares planted. Nigeria produces about 450,000 tones of sesame seed in 2018 with largest Producing state being Jigawa, Nasarawa, Benue and Tataba and exported about 80,000 tones annually which if properly managed can reduce the over dependence of Nigerian economy on crude oil exportation (Benshoshan *et al.*2010). In Africa, Nigeria is the third producer of sesame after Ethiopia and Sudan. African continent is naturally gifted with suitable weather conditions that can enhance sesame production (Tjai, 2002).

Sesame has deep roots and well adapted to withstand dry condition, poor soil, in the climate that is unsuited for other crop and it is widely valued for its nutritional and financial yield. Sesame has short harvest cycle of 90 – 140 days, allowing other crops to be grown in the field and incorporated with other grains (Chemonics, 2002). The three major languages in Nigeria, Hausa, Igbo and Yoruba called it Ridi, Isasa and Ekutu respectively. Sesame is an erect annual plant of numerous types and varieties that can reach 4 -7 feet in height when planted early under high moisture conditions.Numerous wild relatives occur in Africa and a smaller number in India. It is widely naturalized in tropical regions around the world and is cultivated for its edible seeds, which grow in pods (Rosengarten, 2004). Sesame seeds occur in many colours depending on the cultivar. The most traded variety of sesame is off-white coloured. Other common colours are buff, tan, gold, brown , reddish, gray and black (Majumdar, and Roy, 1992). Initiation of flower is sensitive to photoperiod and to sesame variety. The photoperiod also impacts the oil content in sesame seed and increased photoperiod increases oil content. The oil content of the seed is inversely proportional to its protein content (Falusi and salako, 2003). Sesame fruit is a capsule, normally pubescent, rectangular in section and typically grooved with a short, triangular beak. The length of the fruit capsule varies from 2 to 8 cm, its width varies between 0.5 - 2 cm, and the number of loculi varies from 4-12 (Mahajan *et al.*, 2011). The fruit naturally splits open (dehisces) to release the seeds by splitting along the septa from top to bottom or by means of two apical pores, depending on the variety. The degree of dehiscence is of importance in breeding for mechanized harvesting, as is the insertion height of the first capsule (El Khier *et al.,* 2008). Sesame has many species, most being wild and native to Sub-Saharan Africa, the cultivated type originated in India and is tolerant to drought-like conditions, growing where other crops fail (FAO, 2005). Sesame *(Sesamum indicum L.)* is an important source of high quality edible oil and protein food for poor farmers of major sesame growing countries such as Sudan, Nigeria, Ethiopia, Uganda, Mexico, Venezuela, India, China, Pakistan and Turkey (Reckha and Lannger, 2007).

Sodium azide is a chemical mutagen and considers as one of the most powerful mutagen in plant. The application of sodium azide on plant is easy, inexpensive and creates mutation to improve their traits. The efficiency of mutant production depend on many conditions such concentration of sodium azide and treatment duration (Al-Qurainy and Khan, 2009). Sodium Azide is an ionic substance, highly soluble in water, and very acutely toxic which is used in agriculture for pest control of soil-borne pathogens and it also used as a mutagen for crop selection of plants such as rice, sesame, barley or oats, (Awan *et al.*,2000). The physiological effect of Sodium Azide is the inhibition of catalase, peroxidase and cytochrome oxidase and effects in the cell cycle and metabolism. Sodium azide is one of the most powerful mutagens in crop plants that decrease the cellular level of catmodulin, which is a calcium binding protein participating in signal transduction and cell division, (Maryam and Kasimu, 2016). Paradichlorobenzene is a chlorinated aromatic hydrocarbon, fumigant insecticide, repellent and toxic to people and other animals which turn directly from a solid into a gas, a process called sublimation. Para-dichlorobenzene is also called 1, 4-Dichlorobenzene, an organic compound with formula $C_6H_4Cl_2$, a colourless solid compound with a strong odour.

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The molecule consists of a benzene ring with two chlorine atoms (replacing hydrogen atoms) on opposing sites of the ring, (Hunger and Herbst, 2012). Para-dichlorobenzene has been utilized for various cytological procedures by a number of workers and is importance as polyploidizing property and in investigation of the chromosome counts of plants, (Khan and Goyal, 2009). With the realization of this important property of this chemical, it has been successfully applied for chromosome studies in various groups of plant, (Ahloowalia, and Maluszynski, 2001). Mutagenesis is the process causing changes in the genetic information of an organism not caused by genetic segregation but induced by chemical and physical agents (Abou et al., 2017). Chemical or physical mutagen is agents that change the genetic materials, usually DNA of an organism by increasing the frequency of mutations above the natural background level (Ashish et al., 2011). Induce mutation have played a pivotal role in enhancing world food security, as new food crop varieties with various induced mutation which have brought about a significant increase in crop production at locations people could directly access (Kharlkwal and Shu, 2010). In order to produce high yielding and superior genotype cultivars, plant breeders induce mutation in the crop (Norfadzin et al., 2007). When mutation or change occurs in chromosome, pure breeding line give rise to cultivars with different allele of a particular gene leading to increase in production and quality of crop plant (Navnath and Mukund, 2014)

MATERIALS AND METHODS

Pot trials were conducted during 2017and 2018 dry seasons at the teaching and research field in the Department of Plant Biology, Bayero University, Kano, which lies on latitude 11^0 58N and longitude $8\ ^0$ 30E with altitude of 440m above sea level. The site is a typical Sudan Savanna ecological zone of Nigeria. The seeds of the two improved and one Local variety were collected from Kano State Agricultural and Rural Development Authority (KNARDA). The two improved sesame varieties are Ex-Sudan and E-8 and the Local variety is Jan-Iri. A total of hundred (100) seeds of each variety was sorted out and surface sterilized in 1.0% Sodium hypochloride for 1minute. The seeds were then rinsed three (3) times in a sterile distilled water. Ten (10) seeds were sorted and placed in Nylon net bags for easy handling. The seeds were soaked in different concentrations of Sodium azide (0.00mM, 1.0mM, 2.0mM, 3.0mM and 4.0mM) or Para-dichlorobenzene (0.00mM, 1.0mM, 2.0mM 3.0mM and 4.0mM) for three (3) hours. The seeds were then rinsed with distilled water to remove the excess chemicals from the seeds. The treated seeds were planted and resulting plants (M_0) were allowed to produce seeds. The seeds of the M_0 were collected and used to generate M_1 which were used to evaluate the effect of the mutagens.

Top soil was mixed with compost manure in a ratio of 3:1 and placed in a polypots (30 x 30 x 40cm), each at the rate of 7kg per polypot. The treated seeds were sown at the depth of 3cm by dibbling with two fingers and a thumb. Ten (10) seeds per polypot were sown and covered with soil and watered every other day. The seed produced from M_0 generation were replanted to produce the M_1 generation. The experimental design used was Complete Randomized Design (CRD) with eleven treatments and controls. The treatment comprised of chemical mutagens (Sodium Azide :- 0.0mM, 1.0mM 2.0mM 3.0mM and 4.0mM) and (Para dichlorobenzene :- 0.00mM, 1.0mM ,2.0mM 3.0mM and 4.0mM) with three (3) varieties of sesame seed, which were planted in poly-pot (30cm X30cm X 40cm), laid out at 0.5 X 0.5m spacing.

To keep the trial free weeds were controlled manually using hand picking. Each polypot with 7kg soil received 0.35g NPK (15:15:15) and 0.44g urea fertilizer following recommended fertilizer rate for sesame using furrow slice approach, 1 hectare of land contained 2,000,000 kg of soil (if soil bulk density is 3.65g/cm^3 and the rooting depth is 2cm). Therefore, using fertilizer recommendation for sesame as reported by Chude *et al*, (2012), 2 bags of NPK (15:15:15) with 2.5 bags of Urea will be applied per hectare of sesame in Sudan Savanna. Mathematically, this can be expressed as follows:

$$Q = \frac{P X R}{S}$$

Where,
Q = Quantity of fertilizer per polypot (Kg),
P = Weight of the soil in the polypot (Kg),
R = Fertilizer recommendation of the crop per hectare,
S = Weight of soil in kilogram from 1 hectare of land (2,000,000 kg)

RESULTS AND DISCUSSION

The results of the effect of different concentrations of Sodium azide and Para-dichlorobenzene on growth and yield are presented in Table1. The results showed significant difference at (p≤ 0.05) among the treatments. Number of leaves was significantly increased by all the treatments in JAN-IRI except for 1.0 mM Sodium azide (171.0). Similarly, in E-8 only 4.0 mM Sodium azide increased significantly (p≤ 0.05) the number of leaves and the lowest number were obtained in untreated Ex-sudan (96.0) and E-8 (95.0). This could be due to mutagenic effects on quantitative traits resulting in increase in highest number of leaves. This finding was also in conformity with the report of Rahman (2005) on Zea mays, who reported that the number of leaves per seedling, number of pod per plant and number of branches were dose dependant. Similar work was conducted by Juliet and Subramanian (2012) on Black gram (Vigna mungo). Jagajananthan *et al*, (2013) reported the impact of chemical mutagens in plant height and number of leaves decreased with increasing concentration of Diethylsulphate in Soya beans (*Glycine max*).

The result of plant height at maturity is shown in table 2. The result showed that, Para-dichlorobenzene at 3.0 mM produced the highest plant height (152.7cm) in E-8 variety. This was statistically similar to the application of 2.0 mM Sodium azide (150.7cm) in Ex-sudan, 4.0 mM Para-dichlorobenzene (142.0cm) in E-8 and 1.0 mM Para-dichlorobenzene (147.3cm) and 2.0mM Para-dichlorobenzene (142.3cm) for JAN-IRI. The lowest plant height was obtained in plant treated with 2.0 mM Sodium azide (89.0cm) and 3.0 mM Para-dichlorobenzene (93.3cm) in JAN-IRI. This might be attributed to mutagenic effects on quantitative traits resulting in increasing the activity of auxin, which promote plants root and shoot growth influencing water absorption, cell division and cell stretching. Similar result on plant height was reported by Khan and Qurainy (2009) on sesame plant. There was a gradual increasing in plant height when Sodium Azide was used. Similar results were recorded in cowpea (Odeigah *et al.,* 1998), chickpea (Wani and Anis, 2001).

The result on Number of Branches per plant at maturity is shown in table 3. Application of 2.0 mM Sodium azide (37.0) produced the highest number of branches in JAN-IRI. This result was also significant (p≤0.05) for 2.0 mM (36.0) and 3.0Mm Para-dichlorobenzene (31.0) in JAN-IRI, 4.0 mM Sodium azide (32.0) in Ex-sudan and 2.0mM Sodium azide (36.0) in E-8 variety. The least number of branches was obtained when E-8 was treated 3.0 mM Para-dichlorobenzene (21.0). This result was statistically similar to application of 2.0 mM Para-dichlorobenzene (22.0) in Ex-sudan variety.

This might also be as a result of interference with hormone transporting system in the shoot which inhibits bud out growth from the primary shoot apical meristem. Similar result was reported by Takayi and Rahman (1995) on Soya beans (*Glycine max*) who revealed that the number of leaves per seedling, number of pod per plant, number of branches per plant were dose dependant. This is possibly due to mutation effect caused by the mutagens. This was in line with the finding of Mensah and obadoni, (2007) and Gunasekaran (2015) on Ground nut (*Arachis hypogea* L.). Similar result was reported by Yadwad *et al*., (2008) on Chickpea who reported significant shift in quantitative mean performance in number of branches per plant, number of capsule per plant, number of seeds per capsule and seed yield per plant in presence of Sodium azide and Ethylmethane sulphonate.

The result on chlorophyll content is shown in table 4. Application of 1.0 mM Para-dichlorobenzene produced the highest chlorophyll content (56.5 $\mu g/m^2$) in Ex-sudan variety. This result was statistically similar to the application of 1.0 mM Sodium azide (54.5 $\mu g/m^2$) and 4.0 mM Para-dichlorobenzene (49.3 $\mu g/m^2$) in JAN-IRI. The least Chlorophyll Content was obtained in JAN-IRI variety treated with 1.0 mM Sodium azide (22.8 $\mu g/m^2$) and 2.0 mM (22.9 $\mu g/m^2$). Motagi *et al*., 2005 reported the variation in response of the varieties to mutagen in chlorophyll content, a green pigment in leaves which is very important in photosynthesis. The amount of chlorophyll produced per gram in leaf tissue is affected by environmental condition and genetic composition of the plant. Similar observation was also reported by Mondal, *et al.,* (2007) on ground nut variety.

The result of 50% flowering at Maturity is shown in Table 5. Application of 3.0 mM Para-dichlorobenzene (29.0 days) stimulated early emergence of flowers in Ex-sudan. The maximum days to flowering was obtained in plant treated with 3.0 mM Sodium azide (68.0 days), 2.0 mM Para-dichlorobenzene (68 days), 3.0 mM Para-dichlorobenzene (68.0 days) and 4.0Mm Para-dichlorobenzene (67.0 days) both in JAN-IRI variety. This could be due to the changes in the genes that are responsible for switching from vegetative to reproductive phase. The gene stimulates the production of flower and fruit related hormones which consequently resulted in early fruiting and maturity. Mondal, *et al,* (2007) reported early flowering and fruiting process in the crop treated with mutagenic agents. Similar observations were reported by Ricardo and Ando (1998) on rice, Mensal *et al*., (2005) on sesame, Bolbhat and Dhumal (2012) on Ground nut. Late flowering and maturity which could be as a result of changes in genetic and consequently physiology of plant. This result is at variance with work of Adamu *et al*., (2004) but in agreement with Jagajananthan *et al*., (2013) on the use of higher dose of gamma rays radiations on soya beans which suppressed early development of the crop. The development of early maturing variety in any crop primarily depends upon the reduction in the number of days to flowering. Similar findings were also reported in rice (Wang *et al*., 2003), Chilli (Jabeen and Mirza, 2004) and Barley (Ramesh and Kumar, 2005).

The result of Seed weight per plant is shown in Table 6. Seed weight were significantly ($P \leq 0.05$) higher when Ex-sudan were treated with 2.0 mM Sodium azide (11.6g), 2.0 mM Para-dichlorobenzene (10.57). This result was statistically similar with treatment of E-8 with 2.0 mM Sodium azide (10.8g).

The lowest seed weight was produced in untreated JAN-IRI with mean seed weight per plant of 2.49g. The result obtained from the study among the three sesame varieties had shown that there was a clear effect of the mutagens on yield components of sesame crop. This could be observed when varieties were treated with 2.0 mM Sodiuim azide and 1.0 mM Para-dichlorobenzene. This work was in conformity with the report of Waghmare and Mehra, (2003), who reported that there is an increase in yield characters in some varieties of bread wheat and Soyabeans using Ethylmethane Sulphonate, Sodium azide, Nitrosomethyl Urea and Gamma rays.

Table 1. Variety by Mutagen Interaction on Number of Leaves at Vegetative Maturity

			Number of Leaves	
Mutagen	**Concentration** (mM)	**JAN-IRI Mean±SE**	**Ex-sudan Mean±SE**	**E-8 Mean±SE**
Control	0.0	$176.0^{ab}\pm5.6$	$96.0^{f}\pm1.8$	$95.0^{f}\pm3.6$
S.Azide	1.0	$171.0^{bc}\pm3.5$	$102.0^{ef}\pm7.7$	$104.0^{ef}\pm0.9$
S.Azide	2.0	$183.0^{a}\pm0.6$	115.0±8.8	$126.0^{cde}\pm0.7$
S.Azide	3.0	$194.3^{a}\pm1.8$	$117.0^{c\text{-}f}\pm8.6$	$131.0^{cde}\pm2.1$
S.Azide	4.0	$193.0^{a}\pm5.7$	$131.0^{cde}\pm1.8$	$174.0^{ab}\pm3.3$
P. Benzene	1.0	$196.0^{a}\pm4.4$	$120.0^{cde}\pm5.9$	$112.0^{def}\pm0.$
P. Benzene	2.0	$197.0^{a}\pm7.2$	$154.0^{bc}\pm9.4$	$115.0^{def}\pm1.9$
P. Benzene	3.0	$199.0^{a}\pm8.1$	$139.0^{cde}\pm2.9$	$118.0^{c\text{-}f}\pm2.0$
P. Benzene	4.0	$195.0^{a}\pm2.6$	$140.0^{c}\pm2.4$	$125.0^{cde}\pm2.9$

Means followed by the same letter superscripts are not significantly different using least significant difference (LSD) P≤ 0.05 probability level. Key: S.Azide ═ Sodium azide, P. Benzene═ Para-dichlorobenzene, SE± ═ Standard Error.

Table 2. Variety by Mutagen Interaction on Plant Height (cm) at Vegetative Maturity

			Plant Height (cm)	
Mutagen	**Concentration** (mM)	**JAN-IRI Mean±SE**	**Ex-sudan Mean±SE**	**E-8 Mean±SE**
Control	0.0	$105.7^{ghi}\pm5.5$	$109.0^{ghi}\pm2.0$	$117.3^{e\text{-}h}\pm2.4$
S.Azide	1.0	$118.0^{e\text{-}h}\pm2.9$	$106.0^{ghi}\pm2.1$	$120.3^{efg}\pm2.7$
S.Azide	2.0	$89.0^{j}\pm1.2$	$150.7^{ab}\pm7.4$	$120.7^{efg}\pm1.9$
S.Azide	3.0	$129.3^{c\text{-}f}\pm1.2$	$108.3^{ghi}\pm2.7$	$138.7^{b\text{-}e}\pm5.9$
S.Azide	4.0	$119.7^{e\text{-}h}\pm2.4$	$115.3^{fgh}\pm1.5$	$128.7^{c\text{-}f}\pm1.2$
P. Benzene	1.0	$147.3^{abc}\pm1.4$	$103.3^{hij}\pm1.5$	$133.7^{b\text{-}f}\pm2.4$
P. Benzene	2.0	$142.3^{abc}\pm4.5$	$116.3^{fgh}\pm2.9$	$120.3^{efg}\pm4.1$
P. Benzene	3.0	$93.3^{hij}\pm4.0$	$122.7^{d\text{-}g}\pm3.0$	$152.7^{a}\pm2.20$
P. Benzene	4.0	$117.7^{e\text{-}h}\pm6.5$	$138.7^{b\text{-}e}\pm1.5$	$142.0^{abc}\pm5.0$

Means followed by the same letter superscripts are not significantly different using least significant difference (LSD) P≤ 0.05 probability level. Key: S.Azide ═ Sodium azide, P. Benzene═ Para-dichlorobenzene, SE ═ Standard Error.

Table 3. Variety by Mutagen Interaction on Number of Branches at Vegetative Maturity

		Number of Branches		
Mutagen	**Concentration** (mM)	**JAN-IRI Mean ±SE**	**Ex-sudan Mean ±SE**	**E-8 Mean ±SE**
Control	0.0	34.0^{abc}±3.3	27.0^{c-g}±0.3.5	28.0^{c-g}±1.5
S.Azide	1.0	25.0^{d-g}±0.6	29.0^{b-f} ±3.9	30.0^{b-e}±0.4
S.Azide	2.0	37.0^{a}±2.1	25.0^{d-g}±1.2	36.0^{ab}±1.5
S.Azide	3.0	32^{abcd}±0.7	27.0^{c-g}±1.0	26.0^{c-g}±0.9
S.Azide	4.0	30.0^{b-e}±1.6	32.0^{a-d}±1.0	26.0^{c-g}±0.7
P. Benzene	1.0	30.0^{b-e} ±1.2	28.0^{c-g}±1.5	29.0^{b-f}±0.9
P. Benzene	2.0	36.0^{ab}±5.4	22.0^{fg}±1.0	28.0^{c-g}±1.9
P. Benzene	3.0	31.0^{a-d}±3.9	25.0^{d-g}±1.8	21.0^{g} ± 0.6
P. Benzene	4.0	30.0^{b-e}±4.0	26.0^{c-g}±1.8	23.0^{efg}±0.9

Means followed by the same letter superscripts are not significantly different using least significant difference (LSD) P≤ 0.05 probability level. Key: S.Azide ═ Sodium azide, P. Benzene ═ Para-dichlorobenzene, SE± ═ Standard Error.

Table 4. Variety by Mutagen Interaction on Chlorophyll Content (µg/m²) at Vegetative Maturity

		Chlorophyll Content (µg/m²)		
Mutagen	**Concentration** (mM)	**JAN-IRI Mean±SE**	**Ex-sudan Mean±SE**	**E-8 Mean±SE**
Control	0.0	$34.9d^{e-h}$±3.5	30.6^{def}±1.1	27.9^{ghi}±4.5
S.Azide	1.0	22.8^{i}±2.6	54.5^{ab}±0.5	37.8^{def}±5.7
S.Azide	2.0	22.9^{i}±3.5	33.9^{e-h}±1.2	37.8^{def}±0.8
S.Azide	3.0	25.4^{hi}±1.9	40.1^{c-f}±0.9	30.9^{f-i}±0.6
S.Azide	4.0	26.8^{ghi}±2.6	36.2^{d-g}±3.1	27.9^{ghi}±9.3
P. Benzene	1.0	43.7^{bcd}±2.6	56.5^{a}±0.8	37.6^{def}±9.3
P. Benzene	2.0	$2.5.5^{hi}$±1.7	43.6^{b-e}±1.9	39.7^{c-f}±1.6
P. Benzene	3.0	25.3^{hi}±1.4	37.0^{def}±2.1	41.8^{b-f}±1.2
P. Benzene	4.0	27.9^{ghi}±2.0	49.3^{abc}±4.6	46.3^{bcd}±2.2

Means followed by the same letter superscripts are not significantly different using least significant difference (LSD) P≤ 0.05 probability level. Key: S.Azide ═ Sodium azide, P. Benzene═ Para-dichlorobenzene, SE ═ Standard Error.

Table 5. Variety by Mutagen Interaction on Days to 50% Flowering at Maturity

		Days to 50% Flowering		
Mutagen	**Concentration** (mM)	**JAN-IRI Mean±SE**	**Ex-sudan Mean±SE**	**E-8 Mean±SE**
Control	0.0	70.0^{L} ± 0.2	49.0^{h}± 0.2	49.0^{h} ± 0.2
S.Azide	1.0	65.0^{k}± 0.3	45.0^{fg} ± 0.2	45.0^{f} ± 0.2
S.Azide	2.0	52.0^{i}± 0.2	32.0^{b} ± 0.2	34.0^{c} ± 0.2
S.Azide	3.0	68.0^{L}± 0.2	46.0^{g} ± 0.4	37.0^{e} ± 0.2
S.Azide	4.0	65.0^{k} ± 0.2	38.0^{e} ± 0.2	37.0^{e}± 0.2
P. Benzene	1.0	57.0^{j} ± 0.0	34.0^{c} ± 0.2	52.0^{h}± 0.2
P. Benzene	2.0	68.0^{L}± 0.3	44.0^{f} ± 0.2	45.0^{f} ± 0.0
P. Benzene	3.0	68.0^{L} ± 0.2	29.0^{a} ± 0.2	35.0^{cd} ± 0.10
P. Benzene	4.0	67.0^{L} ± 0.2	50.0^{h} ± 0.2	36.0^{de} ± 0.2

Means followed by the same letter superscripts are not significantly different using least significant difference (LSD) ≤ 0.05 probability level. Key: S. Azide ═ Sodium azide, P. Benzene═ Para-dichlorobenzene, SE ═ Standard Error.

Table 6. Variety by Mutagen Interaction on Seed weight (gram/plant)

		Seed Yield Per Plant (g)		
Mutagen	**Concentration** (mM)	**JAN-IRI Mean±SE**	**Ex-sudan Mean±SE**	**E-8 Mean±SE**
Control	0.0	$2.49^{j} \pm 0.02$	$5.9^{g} \pm 0.26$	$4.30^{i} \pm 0.11$
S.Azide	1.0	$4.14^{i} \pm 0.67$	$6.4^{fg} \pm 0.4\ 0$	$7.90^{cd} \pm 0.27$
S.Azide	2.0	$6.50^{fg} \pm 0.13$	$11.6^{a} \pm 0.2$	$10.57^{a} \pm 0.11$
S.Azide	3.0	$6.60^{efg} \pm 0.19$	$8.6^{bc} \pm 0.67$	$5.82^{gh} \pm 0.19$
S.Azide	4.0	$4.12^{i} \pm 0.1$	$8.4^{cd} \pm 0.8$	$10.50^{ab} \pm 0.5$
P. Benzene	1.0	$6.45^{fg} \pm 0.49$	$4.5^{i} \pm 0.40$	$4.40^{i} \pm 0.20$
P. Benzene	2.0	$5.64^{hi} \pm 0.06$	$10.40^{ab} \pm 0.34$	$10.80^{a} \pm 0.14$
P. Benzene	3.0	$4.99^{hi} \pm 0.60$	$7.6^{cde} \pm 0.9$	$4.40^{i} \pm 0.13$
P. Benzene	4.0	$6.36^{fg} \pm 0.5$	$8.8^{bc} \pm 0.67$	$7.30^{def} \pm 0.10$

Means followed by the same letter superscripts are not significantly different using least significant difference (LSD) P≤ 0.05 probability level. Key: S.Azide ═ Sodium azide, P. Benzene═ Para-dichlorobenzene, SE ═ Standard Error.

CONCLUSION

Base on the results obtained from this study, it was concluded that application of 4.0mM Sodium azide recorded the highest number of leaves in E-8 variety while the highest plant height was recorded in plant treated with 3.0mM Para-dichlorobenzene. Application of 1.0mM Para-dichlorobenzene increased the content of chlorophyll in Ex-sudan variety.

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