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Evaluation of the Vegetative and Yield Performances of Groundnut (*Arachis hypogaea*) Varieties Samnut 10 and Samnut 20 Treated With Sodium Azide

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Abstract- Dry seeds of groundnut (*Arachis hypogaea*) varieties Samnut 10 and Samnut 20 obtained from the Ministry of Agriculture, Ilorin, Nigeria were treated with sodium azide concentrations (10, 20, 30, 40 and 50 mM) to evaluate the vegetative and yield performances of the varieties in response to treatment. Low concentrations (10-30 mM) promoted fast germination, though germination, percentage germination and seedling survival decreased with increased in concentrations. Highest vegetative growth was induced by 50 mM concentration 2-week after sowing (WAS) and correlations were established performances of the two varieties in relation to different concentrations of sodium azide. The plant vegetative traits evaluated at 4WAS, 6WAS, and 8WAS showed significance responses to different treatment concentrations. Highest performance was obtained at 50 mM, the trend which was sustained till maturity. Early maturity was achieved in all the concentrations applied and quantitative yield parameters evaluated were highest among 50 mM treated plants. In general, the performances of the two varieties were optimal in responses to 50 mM concentration and both varieties (Samnut 10 and Samnut 20) responded similarly to sodium azide treatment of different concentrations. These findings suggest that sodium azide can be utilised to create variability among existing germplasm for improving vegetative and yield parameters of groundnut.

Index Terms- Arachis hypogaea, early maturity, percentage germination, seedling survival, sodium azide

I. INTRODUCTION

The peanuts or groundnut (*Arachis hypogaea*) is a species in the legume family (Fabaceae). It is an important oilseed legume grown worldwide and is known by many other local names such as earth nuts, pea nuts, goober peas, monkey nuts, and pig nuts [1]. It is grown both for domestic market and for export. The world groundnut production was estimated to be 35.367 million metric tons in 2011/2012, and the word groundnut exports totals approximately 1.25 million metric tons in 2012. The world leading producers are China, India, and USA followed by Nigeria the fourth position and the largest producer in Africa. Groundnut is the 5th most widely grown crop in the sub-Saharan Africa behind maize, sorghum, millet and cassava, where it is grown exclusively for domestic use, either for consumption or as cash crop for smallholder farmers [2], [3].

Groundnut is a nutritive crop with approximately 25% protein and about 45 – 50% oil. The skin of groundnut is rich in vitamin B and it is used as a base ingredient for cosmetics. It also provides important ingredients in numerous industries for sweet, ice-cream, coating, peanut butter and bakery products. Groundnut protein contents is of high biological value as it contains more protein than meat, about two and a half times more than eggs and far more than any other vegetable foods except soya bean and yeast. The residue of the extraction process is used as commercial groundnut cake which is a concentrate feed for livestock and poultry. The nuts are eaten raw or after roasting as snacks. The green leaves or shoot makes excellent fodder and hay for animals [4], [5].

Though, groundnut is an economic crop with lots of industrial potentials and capacity to fit into the array of crops for food security and poverty eradication among the teeming population of the poor rural farmers, the crop is faced with a number of challenges that has contributed to its decline and low production in sub-Saharan African. Low yield, abiotic stress, pest and diseases are major problem facing the crop [6], [7], [8]. Crop improvement through conventional method of breeding may not be able to create desire variability on which a robust breeding programme could be built. Also, groundnut as a self pollinating crop naturally would have less variability in its gene pool and thus limiting the number of natural varieties for which breeders could screen and exploit for improvement purposes.

Crop improvement by mutagenesis has been applied in a number of crops for yield improvement, creation of new cultivars, stress and drought tolerance, disease resistance and for horticultural or floriculture purposes [9], [10], [11], [12]. Induced mutations have been used to improve major crops that are mainly propagated by seeds [13], [14] and to introduce novel genetic variability in ornamental crops. Effects of Sodium azide on crop plants has earlier been reported some decades back [15].

The present study attempts to evaluate the effects of different concentrations of sodium azide on growth and biological yield of two varieties of groundnut commonly grown in Nigeria. It will also assess and compare the responses of the varieties to sodium azide concentrations based on the seedling and growth parameters of the groundnut. This is with a view to determine the possibility of sodium azide becoming a suitable candidate for generation of additional variability in the varieties studied.

II. MATERIALS AND METHOD

Dried Seeds of groundnuts Samnut 10 and Samnut 20 varieties obtained from Kwara State Ministry of Agriculture, Ilorin, Nigeria were used for this investigation. The seeds (nuts) were exposed to different concentrations of freshly prepared sodium azide solution (10, 20, 30, 40 and 50 mM) for 6 hrs. The control seed for each of the varieties were soaked in distilled water for 6 hrs. After, the seeds treated with sodium azide were thoroughly washed in running tap water for ten minutes to remove excess exudates and chemicals from the seeds. Also, the control seeds were removed from distilled water and air dry for about 20 minutes. The treated seeds along with the control were plated in lunch boxes padded with filter papers soaked in distilled water (10 seeds per box) with labels corresponding to the treatment for germination studies. Daily germination observation was made until maximum germination was achieved on the 10^{th} days after sowing. Number of days to germination and percentage germination were determined.

The pot experiment was conducted at Botanical garden, University of Ilorin, Ilorin, Nigeria. Pot studies were undertaken with two seeds sown in a pot (42 cm x 36 cm planting bags) filled with sandy loam soil. Five replicates were made for each of the treatment concentration and control which were arranged along in a Randomized Complete Block Design (RCBD) layout with 0.5 x 0.5 m spacing. Effects of the mutagenic chemical were evaluated on seedling survival, number of leafs, number of branches, leaf length, leaf breadth, plant height and petiole length. These data were collected every fortnight but number of days to flowering, number of days to maturity and number of pod/plant were determined at maturity.

Data obtained from parameter above were subjected to Analysis of variance and the means were separated using Duncan Multiple Range Test (DMRT) at 0.05 probability level. Correlations among the treatment concentrations were also analyzed.

III. RESULTS

The results showed different responses of the two varieties studied to different concentrations of sodium azide in germination studies, growth and yield parameters evaluated. Seed colour, shape and texture were the same before and after the treatments were applied. More than 80% of the seeds germinated within 7 days after planting in lower concentrations of 10 and 20 mM treatment showed good germination effect on both varieties, germination days however became longer with increased concentration. Percentage germination declined as the concentration of sodium azide increases (Fig.1a and 1b).

The quantitative characters studied 2 weeks after sowing (2WAS) showed increase in plant height with increase in treatment concentrations and with respect to the control plants; plant height was positively affected with different concentrations of sodium azide. In Samnut 10, plant height was highest with 50mM treatment with average height of 7.33 cm, while other concentrations and control produced averagely 5.67 cm plant height. Also, highest height of (6.82 cm) was recorded with 50 mM while other treatment concentrations and control ranges between 4.81 – 6.00 cm with control plant producing the least plant height of 4.67 cm among the Samnut 20. The trend was similar for number of leaves, leaf length, leaf breadth and petiole length performance of the two varieties. Different pattern of responses to treatment concentration were recorded by the varieties in terms of number of branches (Table 1). Table 2 revealed the Correlation coefficient showing the relationship between Samnut 10 and Samnut 20 based on plant height at two weeks after planting by concentrations of sodium azide.

At 4, 6 and 8 weeks after sowing (4WAS, 6WAS, and 8WAS), effect of sodium azide treatments on plant height and number of leaves were highest among the 50 mM plants while 10 and 20 mM concentrations recorded the least performance with respect to control in terms of plant height and number of leaves among the two varieties (Fig. 2, 3). The results of mean comparisons for the vegetative characters considered at 10 and 12 weeks after sowing (10WAS and 12WAS) showed significant responses of the varieties to different concentrations of sodium azide as summarized in Tables 3 and 4.

Evaluation of both fruit and nut parameters (Table 5) showed different patterns in performance and responses of Samnut 10 and Samnut 20 to different concentrations of sodium azide. Early maturity was obtained among the chemically treated plants; the number of days to maturity reduces as the concentration increases. Highest average number of pods (76.00 in Samnut 10 and 54.66 in Samnut 20) was obtained from 50 mM plant. Control plants produced 60.33 and 37.66 number of pods per plant in Samnut 10 and Samnut 20 respectively. In addition, weight of 100seeds was highest among 50 mM plants for both varieties.

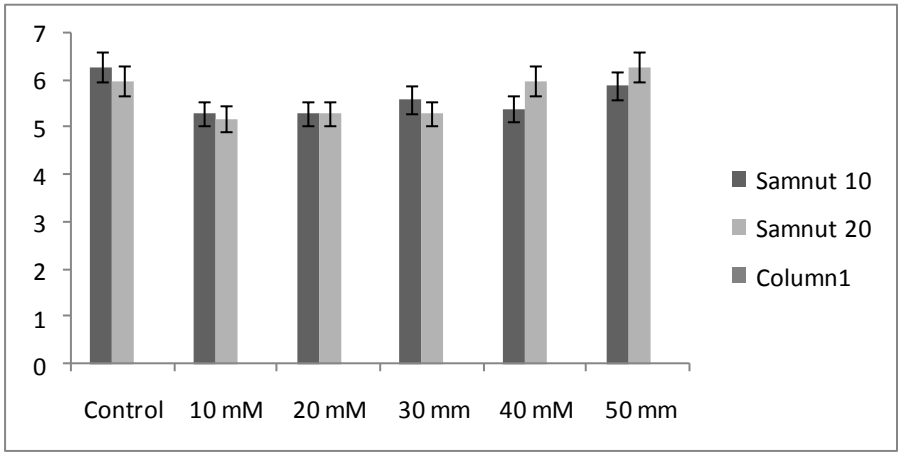

Fig 1a: Effect of sodium azide concentrations on mean number of days to germination of Samnut 10 and Samnut 20 groundnut varieties

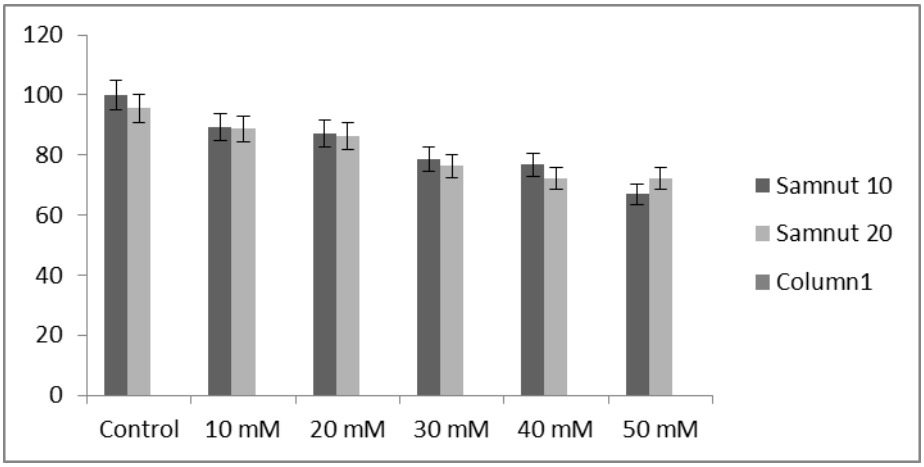

Fig. 1b: Effect of different concentrations of sodium azide on Percentage germination of Samnut 10 and Samnut 20 varieties of groundnut.

Table 1: Effects of Sodium azide on quantitative characteristics of *A. hypogaea* (Samnut 10 and Samnut 20) two weeks after sowing

Variety	Plant Height (cm)	Number of leaf	Number of Branch	Number of leaflet	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)
Samnut 10 Control	5.67±0.33	4.00±0.33	2.67±0.33	16.47±1.33	1.97±0.33	1.23±0.33	1.99±0.05
10 mM	5.67±0.33	3.67±0.33	2.33±0.33	14.67±1.33	1.80±0.00	1.00±0.00	1.77±0.03
20 mM	5.67±0.33	4.00±0.58	2.33±0.33	16.00±2.31	1.90±0.05	1.67±2.67	1.80±0.00
30 mM	5.67±0.33	5.43±0.33	2.12±0.00	22.67±1.33	1.87±0.33	1.17±0.88	1.83±0.06
40 mM	5.67±0.58	5.00±0.58	2.10±0.58	20.00±2.30	1.90±0.05	1.07±0.67	1.87±0.03
50 mM	7.33±0.33	5.58±0.33	2.33±0.33	22.60±1.33	1.97±0.03	1.13±0.67	1.98±0.05
Samnut 20 Control	6.00±0.33	5.67±0.33	2.33±0.33	20.67±1.33	1.93±0.03	1.03±0.33	1.90±0.05
10 mM	4.67±0.33	4.67±0.33	2.25±0.00	18.67±1.33	1.93±0.06	1.00±0.00	1.77±0.03
20 mM	4.81±0.57	5.00±0.58	2.67±0.33	20.00±2.31	1.90±0.05	0.93±0.33	1.80±0.00
30 mM	6.00±0.57	6.00±0.58	2.67±0.33	24.00±2.31	2.06±0.03	1.07±0.33	1.87±0.06
40 mM	6.00±0.57	6.00±0.58	2.33±0.33	24.00±2.31	2.00±1.00	1.07±0.67	1.89±0.03
50 mM	6.82±1.00	6.00±1.00	2.33±0.33	24.00±4.00	2.06±0.08	1.13±0.67	1.90±0.05

Table 2: Correlation coefficient showing the relationship between Samnut 10 and Samnut 20 on Plant height at two weeks after planting

Samnut 20	Control	10 mM	20 mM	30 mM	40 mM	50 mM
Control	1					
10 mM	0.997**	1				
20 mM	0.990**	0.995**	1			
30 mM	0.995**	0.997**	0.993**	1		
40 mM	0.998**	0.994**	0.987**	0.994**	1	
50 mM	0996**	0.994**	0.986**	0.994**	0.998**	1
Samnut 10						
Control	1					
10 mM	0.997**	1				
20 mM	0.990**	0.995**	1			
30 mM	0.995**	0.997**	0.993**	1		
40 mM	0.998**	0.994**	0.987**	0.994**	1	
50 mM	0996**	0.994**	0.986**	0.994**	0.998**	1

**Correlation is significant at the 0.05 level (2-tailed)

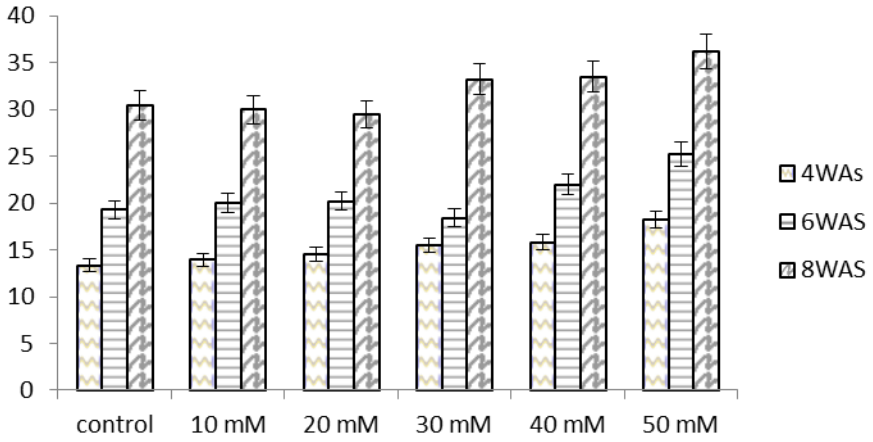

Figure 2a: Effects of Sodium azide on plant height of Samnut 10 four, six and eight weeks after sowing

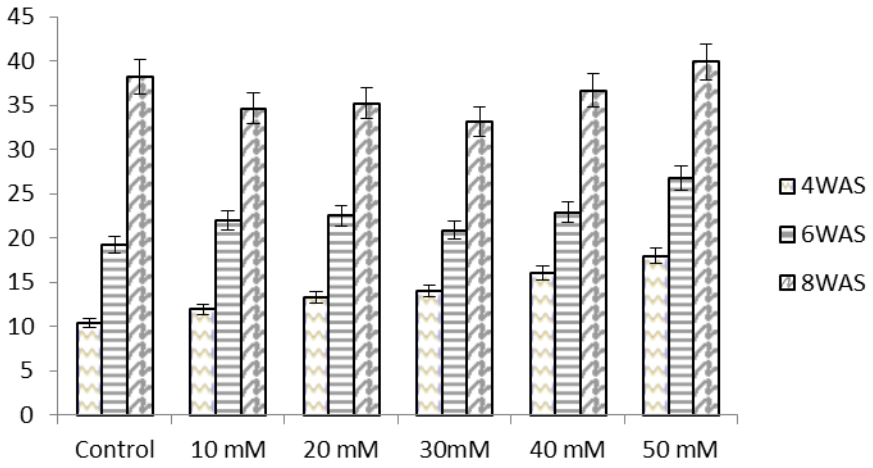

Figure 2b: Effects of Sodium azide on plant height of Samnut 20 four, six and eight weeks after sowing

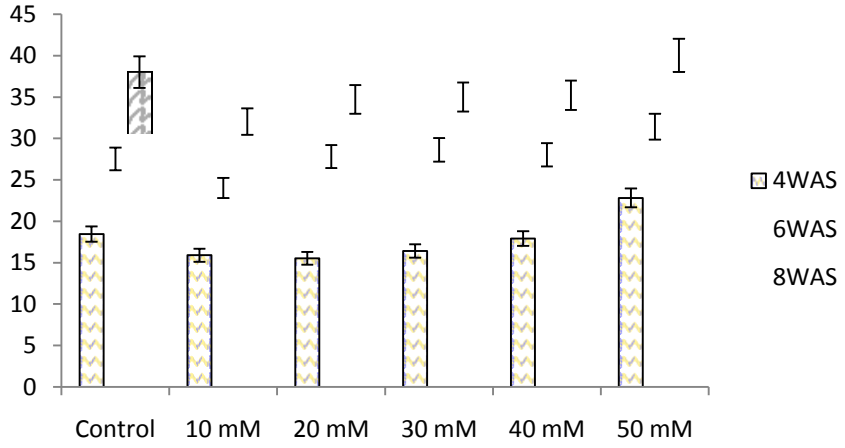

Fig 3a: Effects of sodium azide on number of leaves of Samnut 10 Four, Six and Eight weeks after sowing

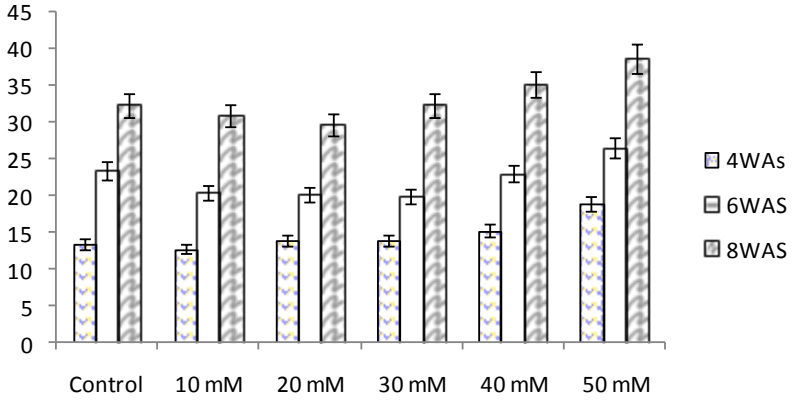

Figure 3b: Effects of Sodium azide on the number of leafs of Samnut 20 four, six and eight weeks after sowing

Table 3: Mean comparison result on the different characters on vegetative growth on the two varieties at ten weeks after sowing

Character	Plant height (cm)	Number of Leaf	Number of branch	Number of leaflet	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)
Samnut 10							
Control	36.93^{d}	47.33^{bc}	7.67^{a}	189.33^{bc}	6.47^{b}	3.13^{cd}	6.37^{d}
10 mM	34.10^{e}	43.00^{d}	8.00^{a}	172.00^{d}	6.40^{b}	3.03^{d}	6.43^{cd}
20 mM	34.63^{d}	45.00^{cd}	8.00^{a}	180.00^{cd}	6.47^{b}	3.16^{bcd}	6.57^{abc}
30 mM	37.57^{c}	48.33^{ab}	8.33^{a}	193.33^{ab}	6.57^{a}	3.23^{abc}	6.47^{bcd}
40 mM	38.60^{b}	48.33^{ab}	7.67^{a}	193.33^{ab}	6.57^{a}	3.30^{ab}	6.60^{ab}
50 mM	39.00^{a}	50.67^{a}	8.30^{a}	206.70^{a}	6.60^{a}	3.36^{a}	6.70^{a}
Samnut 20							
Control	43.66^{d}	52.33^{a}	7.33^{a}	171.00^{b}	6.07^{c}	3.03^{d}	6.70^{b}
10 mM	42.66^{e}	43.00^{bc}	7.33^{a}	170.67^{b}	6.03^{c}	3.00^{d}	6.67^{b}
20 mM	43.67^{d}	45.00^{b}	8.00^{a}	174.67^{b}	6.07^{c}	3.00^{d}	6.67^{b}
30 mM	45.33^{c}	48.33^{b}	7.67^{a}	181.33^{a}	6.23^{b}	3.13^{c}	6.67^{b}
40 mM	45.66^{b}	53.33^{a}	8.00^{a}	182.67^{a}	6.36^{a}	3.20^{b}	7.00^{a}
50 mM	46.33^{a}	54.67^{a}	7.67^{a}	185.33^{a}	6.46^{a}	3.11^{a}	7.00^{a}

Values bearing the same letter(s) along the same column are not significantly different at $p \leq 0.05$

Table 4: Mean comparison result on the different characters on vegetative growth on the two varieties at twelve weeks after sowing

	Plant height (cm)	Number of Leaf	Number of branch	Number of leaflet	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)
Samnut 10							
Control	34.93^{d}	50.67^{ab}	7.67^{a}	202.67^{ab}	6.47^{b}	3.13^{cd}	7.04^{d}
10 mM	34.10^{e}	47.33^{c}	8.00^{a}	189.33^{c}	6.40^{b}	3.03^{d}	6.90^{cd}
20 mM	34.63^{d}	49.00^{bc}	8.00^{a}	194.00^{bc}	6.47^{b}	3.16^{bcd}	7.11^{abc}
30 mM	37.57^{c}	52.00^{ab}	8.33^{a}	208.00^{a}	6.57^{a}	3.23^{abc}	7.23^{bcd}
40 mM	38.60^{b}	52.00^{ab}	7.67^{a}	208.00^{a}	6.57^{a}	3.30^{ab}	7.44^{ab}
50 mM	39.00^{a}	53.67^{a}	8.30^{a}	214.67^{a}	6.60^{a}	3.36^{a}	7.60^{a}

Samnut 20							
Control	34.93^{d}	47.00^{b}	7.33^{a}	188.00^{b}	6.50^{a}	3.33^{cd}	7.14^{b}
10 mM	34.10^{e}	47.33^{b}	7.33^{a}	189.33^{b}	6.15^{c}	3.23^{d}	7.10^{b}
20 mM	34.63^{d}	48.67^{b}	8.00^{a}	194.67^{ab}	6.33^{b}	3.23^{d}	7.140^{b}
30 mM	37.57^{c}	49.67^{a}	7.67^{a}	198.67^{a}	6.19^{c}	3.36^{c}	7.11^{b}
40 mM	38.60^{b}	49.33^{a}	8.00^{a}	197.33^{a}	6.50^{a}	3.43^{b}	7.78^{a}
50 mM	39.00^{a}	50.00^{a}	7.67^{a}	200.07^{a}	6.50^{a}	3.50^{a}	7.80^{a}

Values bearing the same letter(s) along the same column are not significantly different at p≤0.05

Table 5: Effect of Sodium azide on the fruit character of two varieties of *A. hypogaea*

	Number of days to maturity	Number of pods/plant	Number of nuts/pod	100 seed/ weight (g)
Samnut 10				
Control	65.67^{a}	60.33^{c}	2.58^{c}	49.87^{c}
10 mM	65.33^{a}	59.00^{c}	1.98^{d}	50.67^{b}
20 mM	57.00^{bc}	48.33^{cd}	2.81^{b}	51.36^{b}
30 mM	62.00^{b}	52.33^{d}	1.96^{d}	53.15^{ab}
40 mM	59.00^{bc}	72.00^{b}	2.85^{a}	55.39^{a}
50 mM	53.067^{c}	76.00^{a}	2.85^{a}	55.44^{a}
Samnut				
Control	65.67^{a}	47.66^{b}	2.67^{b}	73.24^{d}
10 mM	66.33^{a}	47.00^{b}	2.00^{c}	75.06^{c}
20 mM	65.18^{a}	47.33^{b}	1.67^{d}	73.17^{d}
30 mM	59.00^{b}	45.33b^{c}	2.33^{bc}	86.12^{b}
40 mM	55.08^{ab}	44.33^{c}	2.67^{b}	88.10^{ab}
50 mM	50.17^{c}	54.66^{a}	2.99^{a}	89.61^{a}

Values bearing the same letter(s) along the same column are not significantly different at p≤0.05

IV. DISCUSSION

The vegetative and yield parameters considered showed distinctive responses of the two varieties to sodium azide treatment of different concentrations. The ability of the seeds with treatment ranges from 10 -30 mM to germinate within 5-6 days for the two varieties showed that sodium azide of such less concentrations could induced increase enzymatic and metabolic activities which could be responsible for the early germination. However, there were reductions in germination with increase in concentrations of sodium azide above the range. Reduction in percentage germination and seedling survival due to effect of mutagens has being reported in crop plants [15], [17], [18].

Higher concentrations of 40 and 50 mM improved seedling vegetative growth parameters studied 2WAS. Plant height and number of leaves were positively affected by these higher concentrations of mutagen. This finding is in contrast to report of [18] who reported that plant height decreases as mutagenic concentration increases while working on sesame seed. The positively induced height by 40 and 50 mM concentrations of sodium azide could have arisen as a result of the treatment ability to stimulate production of growth hormones. Correlation analysis revealed that significant correlation exits in the performance and responses of Samnut 10 and Samnut 20, in plant height with respect to different concentrations applied. This implies that in term of plant height at 2WAS; both varieties responded similarly to different sodium azide concentrations.

In most of the growth parameters studied, 50 mM consistently produced significant effects on the two varieties from 2WAS to maturity (12WAS). Tallest plants with higher number of leave were obtained with this high concentration of mutagen. This indicates that the induced plant growth hormone by this treatment concentration is sustained throughout vegetative growth phase of the crop. However, various concentration used in this studied did not significantly affect the number of branches with respect to the control. Early maturity and heavier seed (nuts) were achieved in all the tested concentrations of sodium azide, which is similar to findings of [19]. Average number of pods per plant, mean number of nuts in a pod and mean weight of 100 nuts were highest in 50 mM for both varieties suggesting that these traits were dose dependent as previously opined [20]. This report is further corroborated by [18] who opined that application of higher concentration of sodium azide and Colchicine produced early maturing mutants with increased in number and fruits size.

V. CONCLUSION

Sodium azide was effective in inducing early germination at low concentrations, higher concentrations would produce adverse effect on percentage germination and seedling survival in groundnut. High concentration of 50 mM had optimal effects on vegetative and yield parameters considered in this study. Lower doses of 10-30 mM were probably too low to induce desirable agronomy characters in the crop. Sodium azide therefore could be utilized to increase variability in groundnut that ultimately increased the possibility of isolating beneficial mutants for groundnut improvement. Various concentrations could further be screened towards targeted traits which could be selected for breeding improved varieties and subsequently expand the existing germplasm.

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