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SODIUM AZIDE-INDUCED GENETIC VARIATION OF MORPHOLOGICAL TRAITS IN *CAPSICUM* ACCESSIONS

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ABSTRACT

This study evaluated the effect of sodium azide-induced mutagenesis on the growth performance of various Capsicum spp accessions. Significant variation was observed across growth traits: number of leaves, leaf length, leaf width, plant height, stem girth, and canopy width. While some accessions, such as NGB00622 and NGB00601, failed to germinate, others exhibited notable performance disparities. NGB00703 emerged as the top-performing accession, excelling across multiple growth traits, followed by NGB002642 and NGB00701. Conversely, NGB02626 and NGB02730 displayed consistently poor growth metrics. Sodium azide-induced variants demonstrated marked improvements in growth traits compared to their controls, particularly in plant height, stem girth, and leaf dimensions. These enhancements were observed not only in high-performing accessions but also in low-performing ones, indicating the mutagen's potential to induce beneficial genetic variability. The findings underscore sodium azide's utility in generating genetic diversity within Capsicum spp., providing a basis for future breeding and genetic improvement programs.

Keywords: *Capsicum* spp., Sodium azide, Mutagenesis, Growth traits, and Genetic variability.

INTRODUCTION

Capsicum species, particularly *C. annuum* (bell pepper) and *C. frutescens* (chili pepper), are economically important crops cultivated worldwide for their culinary and nutritional values (Olawuyi *et al*., 2014; Batiha *et al*., 2022; Ďúranová *et al*., 2022). These species belong to the Solanaceae family, and are grown in diverse climatic conditions for their rich content of vitamins and capsaicin, the compound responsible for the pungency of peppers (Barceloux, 2009; Bal *et al*., 2022). *Capsicum* is not only a major crop in food production but also a key player in the global spice and seasoning markets. Additionally, *Capsicum* cultivars are used in pharmaceutical and medicinal applications, including the production of pain relief creams and as natural antioxidants (Batiha *et al*., 2020). However, the cultivation of *Capsicum* species faces numerous challenges, including susceptibility to diseases, pests and environmental stresses, which can significantly affect their growth and yield (Bojórquez-Quintal, 2012; Olawuyi *et al*., 2014).

To address these challenges, crop improvement strategies such as breeding programs, are employed to enhance desirable traits such as yield, disease resistance, stress tolerance and nutritional quality (Olawuyi *et al*., 2014). Traditional breeding methods however, can be time-consuming, expensive and often limited by the genetic diversity available within the germplasm (Omeke, 2021). As a result, alternative methods, such as mutagenesis, have gained popularity in recent years. Mutagenesis refers to the use of physical or chemical agents to induce genetic mutations, creating genetic variability that can be harnessed for crop improvement. Chemical mutagenesis, in particular, has been widely used in many plant species due to its simplicity and effectiveness. Sodium azide (NaN_3) is one such chemical mutagen that has been shown to induce genetic variability in several crops (D Gruszka *et al*., 2012).

Sodium azide is a potent mutagen that can induce a wide range of mutations, including point mutations, deletions, and chromosomal aberrations, by interfering with DNA replication and repair mechanisms (D Gruszka *et al*., 2012; Olawuyi & Okoli, 2017; Olawuyi *et al*., 2021). The use of sodium azide in plant mutagenesis has been documented in various studies, showing its ability to generate mutations that can lead to improvements in agronomic traits such as plant height, fruit size, and disease resistance (Olawuyi & Okoli, 2017; Olawuyi *et al*., 2021). Moreover, sodium azide mutagenesis offers the advantage of being relatively safe and inexpensive compared to other mutagenic agents like gamma radiation, making it an attractive option for large-scale breeding programs (Sikora *et al*., 2011). However, the effectiveness of sodium azide in inducing beneficial mutations varies across plant species and accessions, and the identification of suitable concentrations and treatment durations is critical to maximizing the mutagenic potential while minimizing deleterious effects on plant viability (D Gruszka *et al*., 2012; Türkoğlu *et al*., 2022).

Capsicum species, with their wide genetic variation and potential for improvement (Hasan *et al*., 2024), represents an ideal candidate for mutagenesis studies aimed at enhancing agronomic traits. Previous studies have successfully applied chemical mutagenesis to *Capsicum*, resulting in the generation of mutants with improved characteristics such as increased yield, resistance to pests and diseases, and enhanced fruit quality (Hasan *et al*., 2024). Furthermore, studies on other crops, such as the work by Olawuyi & Oladele (2023) on the genetic variability induced by gamma radiation in African yam bean (*Sphenostylis stenocarpa*), have shown the importance of mutagenesis in generating variability that can be exploited for crop improvement. Similarly, Olawuyi & Ajie (2023) observed significant morphological and molecular variability in tomato accessions, highlighting the potential of mutagenesis for improving growth and yield in crop species. Also, in a study on maize (*Zea mays*), X-ray-induced mutations were used to generate phenotypic and molecular variability, demonstrating the effectiveness of induced mutations in crop improvement (Olawuyi *et al*., 2020). However, there remains a need for further research to explore the genetic variability induced by sodium azide and its impact on various growth characters in different *Capsicum* accessions.

The present study aims to evaluate the effects of sodium azide mutagenesis on the growth performance of eight *Capsicum* accessions obtained from the National Centre for Genetics Resources and Biotechnology (NACGRAB). Specifically, the study investigates the potential of sodium azide to induce genetic variability in growth characters such as plant height, stem length, leaf length, and stem diameter, with the goal of identifying accessions with enhanced traits for future breeding programs. We hypothesize that sodium azide treatment will induce genetic variability in *Capsicum* accessions, leading to significant changes in growth characters. Furthermore, we aim to determine whether the mutagenesis treatment produces any beneficial

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mutations that could be selected for improved agronomic performance. By evaluating the growth responses of different *Capsicum* accessions to sodium azide treatment, this study provides valuable insights into the potential for using chemical mutagenesis as a tool for enhancing *Capsicum* breeding efforts.

MATERIALS AND METHODS

Plant Material

The study was conducted using *Capsicum* accessions obtained from the National Centre for Genetics Resources and Biotechnology (NACGRAB). A total of ten *Capsicum* accessions listed in Table 2 were selected for this study based on their varying agronomic characteristics and availability. The seeds of these accessions were sourced from the respective institutions and stored in optimal conditions prior to use. A plot of land in the nursery unit of the Department of Botany, University of Ibadan, was cleared for the placement of polythene bags containing the soil and seeds from the different accessions.

Sodium Azide Treatment

Seeds of the selected *Capsicum* accessions were treated with sodium azide (NaN_3) following a slight modification of the procedure reported by Omeke (2021). Sodium azide solutions were prepared by dissolving sodium azide in 100 ml of distilled water to achieve concentrations of 0.02% (for S2) and 0.04% (for S3) (w/v) respectively. Seeds were immersed in the respective solutions for 6 hours, followed by thorough washing with distilled water to remove any residual mutagen. A control group (S1) of seeds were treated similarly but without the mutagenic agent. All the treatments and control were prepared in three replicates.

Germination and Plant Growth Conditions

The treated seeds were sown in germination trays filled with sterilized potting soil. The trays were placed in a growth chamber maintained at a constant temperature of 25°C with a 12-hour light/dark photoperiod. The relative humidity was maintained at 70-80%. Germination was monitored daily, and the number of seeds that successfully germinated were recorded for each accession. Seedlings were transferred to larger pots once they reached the four-leaf stage to allow further growth and development.

Growth Characters

The growth characters were measured to evaluate the performance of the *Capsicum* accessions included plant height, stem length, stem girth, leaf length, leaf width, canopy width, and the number of leaves. Plant height was measured from the base of the plant to the tip of the highest leaf using a ruler at weekly intervals. Stem length was measured from the soil level to the point of the first leaf, while stem diameter was assessed using a vernier caliper at the base of the stem. Leaf length was recorded as the longest dimension of the largest leaf, and leaf width was taken as the widest dimension of the largest leaf. Canopy width was measured as the distance between the widest points of the plant’s canopy. The number of leaves was determined by counting the total number of fully developed leaves on each plant. These measurements were taken weekly for a period of 8 weeks, and the average value for each parameter was calculated for each accession.

Statistical Analysis

The data were analyzed using descriptive statistics to determine the mean, standard deviation, and range of the measured traits. Analysis of variance (ANOVA) was performed to assess the effect of sodium azide treatment on the growth characters of the different *Capsicum* accessions. Post-hoc pairwise comparisons were conducted using Tukey’s test to determine significant differences between treated and untreated accessions. The significance level was set at $p \leq 0.05$ for all statistical tests. All data analyses were conducted using SPSS software (version 22.0, IBM).

RESULTS

Mean Square Variance on Growth Characters of *Capsicum* spp. Induced with Sodium Azide.

As shown in Table 1, accession had highly significant ($p < 0.001$) effects on plant height, leaf length, leaf width, stem girth, and canopy width, while a significant ($p < 0.01$) effect was observed for the number of leaves. The mutagenic effect of sodium azide significantly ($p < 0.05$) affected plant height, leaf length, and stem girth, while leaf width, number of leaves, and canopy width showed no significant effects. Growth stages (week) had highly significant ($p < 0.01$) effects on plant height and number of leaves, with significant ($p < 0.05$) effects on stem girth. Leaf length and leaf width showed no significant differences. The first-order interaction (accession × treatment) produced significant effects on growth characters, except for canopy width, while the second-order interactions (accession × treatment × week and treatment × week) were not significant.

Germination and Mean Performance on Growth Characters of *Capsicum* spp. Induced with Sodium Azide.

A total of 10 *Capsicum* accessions were evaluated for germination success and growth performance. NGB00622 and NGB00601 failed to germinate, indicating complete inhibition, while all other accessions showed germination rates between 50% and 100%. NGB00703 and NGB00701 had the highest germination rates (100%), while NGB02626 had the lowest at 50%. The growth performance of the selected *Capsicum* accessions treated with sodium azide varied significantly across measured characters as shown in Table 2. Accession NGB00703 showed the highest significance ($p < 0.05$) in plant height compared to other accessions, with no significant differences between at least four comparisons of other accessions for plant height. Minimal PH was observed in NGB00700 (1.31cm) and NGB02730 (2.4 cm). Moderate growth was recorded in NGB02626 (PH: 4.30 cm, LL: 1.55 cm, NOL: 7.95, CW: 3.52 g). NGB00701 had the most significant leaf length among the accessions, while no significant differences were found between NGB02730, NGB00700, NGB00601, and NGB00622.

Overall, superior growth was observed in accessions NGB00626, NGB02634, NGB00701, NGB02642, and NGB00703, with PH ranging from 7.79 cm to 15.81 cm, LL from 2.31 cm to 3.94 cm, and CW from 10.56 g to 15.50 g. Notably, NGB00703 exhibited the tallest plants (15.81 cm) and widest leaves (2.64 cm), while NGB02642 had the highest number of leaves (27.46) and substantial capsule weight (15.24 g).

Effect of Sodium Azide concentration (treatment) on Growth Characters of *Capsicum* spp.

As shown in Table 3, control (S1) exhibited significantly higher values ($p<0.05$) than other treatments for plant height (7.03 cm), leaf length (2.02 cm), leaf width (1.34 cm), stem girth (0.15 cm), number of leaves (14.40), and canopy width (309.05 cm). The 0.02g concentration (S2) differed significantly from 0.04g (S3) for plant height, leaf length, stem girth, and number of leaves, but no significant difference was observed between S2 and S3 for leaf width and canopy width.

Effect of Weeks on Growth Characters of *Capsicum* spp.

Plant growth characters, including plant height (PH), leaf length (LL), leaf width (LW), stem girth (SG), and number of leaves (NOL), showed significant variations across seven weeks (in Table 4). The PH steadily increased from 4.32 cm in Week 1 to 7.68 cm in Week 7, while LL peaked at 2.04 cm in Weeks 5 and 6 before slightly declining. LW increased from 0.85 cm in Week 1 to a maximum of 1.54 cm in Week 4, followed by minor fluctuations. SG showed minimal but consistent growth, reaching 0.16 cm by Week 7. NOL exhibited the most significant change, rising sharply from 3.83 leaves in Week 1 to 23.01 leaves in Week 7. These findings highlight consistent

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growth in most characters, particularly PH and NOL, with the most substantial changes occurring during the first six weeks.

Correlation Coefficients of Growth Characters in *Capsicum* spp.

Pearson's correlation analysis shown in Table 5 indicates that, plant height was significantly positively correlated with leaf length (r = 0.93), leaf width (r = 0.78), stem girth (r = 0.93), number of leaves (r = 0.82), and canopy width (r = 0.70). Leaf length showed positive associations with leaf width (r = 0.86), stem girth (r = 0.91), number of leaves (r = 0.78), and canopy width (r = 0.71). Stem girth was positively correlated with the number of leaves (r = 0.79) and canopy width (r = 0.72), while the number of leaves was positively associated with canopy width (r = 0.59).

Principal component analysis of morphological characters of *Capsicum* spp.

The principal component analysis (PCA) shown in Table 6 revealed that the first two principal components (PRIN 1 and PRIN 2) accounted for a cumulative variance of 80.03%, with PRIN 1 alone contributing 68.70% of the total variance. PRIN 1 exhibited strong positive effects (>0.90) for plant height, leaf length, leaf width, stem girth, and number of leaves, indicating that these traits are major contributors to overall phenotypic variation. Plant canopy width and emergence day also showed moderate positive loadings on PRIN 1. In contrast, PRIN 2, which explained 11.34% of the variance, was characterized by high positive loadings for days to fruiting (0.78) and days to flowering (0.53), suggesting that these temporal traits are distinct drivers of variation in this component. This analysis further highlights the dominance of vegetative growth traits in PRIN 1 and reproductive traits in PRIN 2.

Table 1: Mean square variance on growth characters of *Capsicum spp*. treated with Sodium azide.

Source of variation	df	NOL	LL	LW	PH	SG	CW
Corrected model	209	865.24***	9.33***	4.74***	125.87***	0.05***	203.68***
Intercept	1	93087.24***	2095.19***	907.92***	25569.82***	11.37***	4549.69***
Accession	9	7026.82***	141.38***	57.26***	1931.90***	0.80***	440.88***
Treatment	2	880.08^{ns}	14.4*	3.00^{ns}	148.15*	0.81*	121.64^{ns}
Week	6	5677.60 ***	5.88^{ns}	4.25^{ns}	137.52*	0.05*	-
Accession*Treatment	18	1777.42***	26.20***	13.15***	318.83***	0.146***	94.20^{ns}
Accession*Week	54	74.96 *	1.03^{ns}	1.3^{ns}	16.97^{ns}		-
Treatment*Week	12	211.89^{ns}	1.57^{ns}	1.20^{ns}	15.04^{ns}		
Accession*Treatment*Week	108	349.62^{ns}	0.63^{ns}	1.12^{ns}	8.908^{ns}		
Error	420	667.88	3.66^{ns}	2.37			
Total	630	520.95					
Corrected total	629						

NOL-Number of leaves, LL- leaf length, LW- leaf width, SG- stem girth, CW-canopy width. Significant at $p < 0.05$, ** = Highly significant at $p < 0.01$, ns = Non –significant, df = degree of freedom.

Table 2: Mean Performance on Growth Characters of *Capsicum* spp. treated with Sodium Azide.

ACCESSION	PH (cm)	LL (cm)	LW (cm)	SG (cm)	NOL	CW
NGB00622	0.00^{e}	0.00^{e}	0.00^{e}	0.00^{e}	0.00^{e}	0
NGB00601	0.00^{e}	0.00^{e}	0.00^{e}	0.00^{e}	0.00^{e}	0
NGB00700	1.311^{e}	0.36^{e}	0.26^{d}	0.04^{d}	2.44^{de}	0
NGB02730	2.41^{de}	0.68^{e}	0.45^{d}	0.05^{d}	3.3^{de}	0

NGB02626	4.30^{d}	1.55^{d}	1.42^{c}	0.1^{c}	7.95^{d}	3.52^{bc}
NGB00626	7.79^{c}	2.31^{c}	1.41^{c}	0.18^{a}	17.32^{c}	15.50^{a}
NGB02634	9.58^{bc}	2.8^{bc}	1.92^{bc}	0.17^{b}	18.57^{bc}	10.56^{ab}
NGB00701	10.90^{b}	3.94^{a}	1.80^{bc}	0.25^{a}	19.81^{bc}	14.67^{a}
NGB02642	11.60^{b}	3.22^{b}	2.09^{b}	0.25^{a}	27.46^{a}	15.24^{a}
NGB00703	15.81^{a}	3.38^{ab}	2.64^{a}	0.30^{a}	24.7^{ab}	11.61^{ab}

Table 3: Effect of sodium azide concentrations (treatments) on growth characters of *Capsicum* spp.

Treatment	PH (cm)	LL (cm)	LW (cm)	SG (cm)	NOL	CW
S1	7.03	2.02	1.34	0.15	14.4a	9.05
S2	6.66	1.92	1.16	0.14	11.69ab	7.25
S3	5.43	1.53	1.11	0.11	10.38b	5.03

PH plant height, LL- leaf length, LW- leaf width, SG- stem girth, NOL- number of leaves, CW-canopy width.

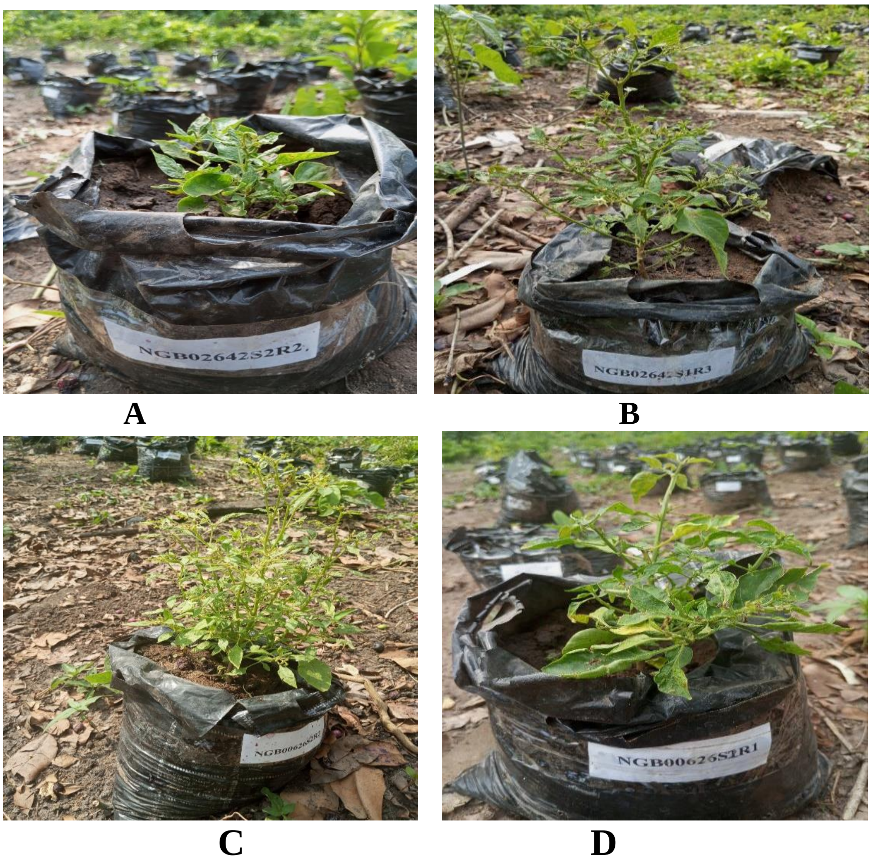

Plate 1: Photographs showing representative cultivars of sodium-azide treated and untreated (control) accessions. (a) NGB02642 at 0.02% (b) control for NGB02642 (c) NGB00626 at 0.02% (d) control for NGB00626.

Table 4: Effect of weeks on growth characters of *Capsicum* spp treated with Sodium azide.

WEEK	PH (cm)	LL (cm)	LW (cm)	SG (cm)	NOL
WEEK 1	4.32^{c}	1.32^{b}	0.85^{b}	0.12^{ab}	3.83^{d}
WEEK 2	5.24^{bc}	1.72^{ab}	1.14^{ab}	0.11^{a}	4.87^{cd}
WEEK 3	6.00^{abc}	1.89^{ab}	1.23^{ab}	0.12^{ab}	6.74^{cd}
WEEK 4	6.79^{ab}	2.03^{a}	1.54^{a}	0.12^{ab}	10.42^{bc}

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WEEK 5	7.23^{ab}	2.04^{a}	1.34^{ab}	0.15^{a}	13.91^{b}
WEEK 6	7.33^{ab}	2.00^{a}	1.23^{ab}	0.16^{a}	22.3^{a}
WEEK 7	7.68^{a}	1.77^{ab}	1.06^{ab}	0.16^{a}	23.01^{a}

Means with the same letter in the same column are not significantly different at $p<0.05$ using Duncan's Multiple Range Test (DMRT)

Table 5: Pearson's correlation coefficients of growth characters in *Capsicum* spp.

	Plant height	Leaf length	Leaf width	Stem girth	Number of leaves	Plant canopy width	Emergence day	Days to flowering
Leaf length	0.93**							
Leaf width	0.78**	0.86**						
Stem girth	0.93**	0.91**	0.75**					
Number of leaves	0.82**	0.73**	0.60**	0.79**				
Plant canopy width	0.70**	0.72**	0.75**	0.72**	0.59*			
Emergence day	0.63**	0.66**	0.68**	0.67**	0.60**	0.55*		
Days to flowering	0.50*	0.44ns	0.45**	0.48ns	0.49ns	0.53*	0.36ns	
Days to fruiting	0.32ns	0.29ns	0.27ns	0.27ns	0.41ns	0.33ns	0.26ns	0.39ns

*= Significant at $p<0.05$, **= Highly significant at $p< 0.01$, ns = non-significant.

Table 6: Principal component axes of morphological characters of *Capsicum* spp.

Characters	PRIN 1	PRIN 2
Plant height	0.95	-0.13
Leaf length	0.96	-0.18
Leaf width	0.95	-0.18
Stem girth	0.95	-0.17
Number of leaves	0.92	-0.19
Plant canopy width	0.80	0.09
Emergence day	0.74	-0.10
Days to flowering	0.59	0.53
Days to fruiting	0.42	0.78
% Variance	68.70	11.34
Cummulative (%)	68.70	80.03

DISCUSSION

This study assessed the effects of sodium azide-induced mutagenesis on various growth characters of *Capsicum* spp. and examined how different accessions responded to the mutagenic treatment. Significant variability in growth traits was induced across accessions, highlighting sodium azide's potential for creating genetic diversity, which could be harnessed for crop improvement.

Impact of Sodium Azide on Growth Characters

The results indicated that sodium azide treatment significantly influenced growth characters such as plant height, leaf length, stem girth, and number of leaves. This suggests that sodium azide treatment can induce substantial genetic diversity in these traits, which could be advantageous for breeding programs aiming to enhance specific growth attributes. Similar results were observed in the *African yam bean* (*Sphenostylis stenocarpa*), where induced mutation through gamma radiation led to significant changes in growth characteristics, though some doses caused lethal effects, which underscores the importance of optimizing mutagenic treatments for specific (Olawuyi *et al*., 2023). Also, in maize and Bambara groundnut, sodium azide-induced mutations showed significant genetic variability in growth and agronomic traits

(Olawuyi & Okoli, 2017; Olawuyi *et al*., 2021).

Notably, the accession NGB00703 exhibited the highest mean values for several growth traits, including plant height, leaf length, and number of leaves. The treatment induced a significant increase in plant height, leaf length, and the number of leaves in this accession, suggesting that sodium azide could be effective in enhancing desirable traits in certain accessions. In contrast, other accessions such as NGB02626 showed limited or no improvement despite mutagenic treatment, which emphasizes the variability in mutagenic response among different *Capsicum* accessions. This variability is in line with findings from studies on *African yam bean*, where differing mutagenic treatments (e.g., gamma radiation) produced accession-specific responses, indicating that genetic background plays a significant role in determining mutagenic outcomes (Oladele & Olawuyi, 2023).

The first principal component (PRIN 1) explained 68.70% of the total variance and was primarily influenced by traits such as plant height, leaf length, leaf width, stem girth, and number of leaves. These traits exhibited strong positive loadings (>0.90), emphasizing their central role in phenotypic variation and their potential as targets for mutagenesis. PRIN 2 accounted for an additional 11.34% of the variance and was associated with reproductive traits, particularly days to flowering and days to fruiting, suggesting that these traits represent a distinct dimension of variability. This finding is similar to those in our earlier studies on sodium azide and X-ray-induced mutagenicity in maize (Olawuyi *et al*., 2017; 2021). This multivariate approach highlights how sodium azide mutagenesis can influence both vegetative and reproductive growth characters, making it a versatile tool for breeding programs.

Interaction Effects on Growth Characters

The first-order interaction between accession and treatment had a significant effect on most of the growth traits except for canopy width. This suggests that the response to sodium azide mutagenesis is accession-dependent, and the specific genetic makeup of each accession influences how it responds to the treatment. However, the second-order interactions (accession × treatment × week and treatment × week) were not significant, indicating that the effects of mutagenesis on growth characters were relatively consistent over time and were not influenced by the growth stages.

Germination Success and Growth Performance

The germination success of the accessions varied significantly, with NGB00703 and NGB00701 exhibiting 100% germination rates, while NGB02626 had the lowest germination rate (50%). These findings aligned with previous studies that have demonstrated variation in mutagenesis-induced germination rates across plant species. In *African yam bean*, for example, varying doses of gamma radiation affected germination success, with lower doses yielding better results and higher doses leading to a significant decrease in pollen fertility (Olawuyi *et al*., 2023). Such variability in germination success emphasizes the need to optimize mutagenic treatments for different accessions and conditions.

Moreover, the genetic variability induced by sodium azide mutagenesis in *Capsicum* is similar to findings in other crops subjected to physical radiation. For instance, in a study on maize, X-ray mutagenesis induced significant phenotypic changes in plant height, leaf length, and other traits, with genetic variability observed in both morphological and molecular assessments (Olawuyi *et al*., 2021). This underscores the potential of mutagenesis, whether chemical or physical, to introduce beneficial traits in crop species with diverse genetic backgrounds.

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Regarding growth performance, significant differences in plant height, stem length, leaf length, leaf width, and canopy width were observed among accessions. NGB00701 and NGB00703 consistently showed superior growth compared to other accessions. These results are consistent with the idea that mutagenesis can enhance growth traits such as plant height and leaf size, which are vital for improving crop yield. Sodium azide treatment significantly increased plant height, leaf length, and the number of leaves in NGB00701, indicating its potential as a candidate for further breeding. This observation parallels findings in other crops, where induced mutations, such as those using sodium azide or gamma radiation, have been shown to positively influence growth and yield-related traits (Olawuyi & Ajie, 2023; Olawuyi *et al*., 2023).

The higher variability in growth traits induced by sodium azide treatment is consistent with the effects of other mutagenic treatments in various crops, including *African yam bean*, where induced mutations led to significant changes in traits like seed germination, seed set, and plant height in accordance with the reports of Olawuyi & Ajie (2023) and Olawuyi *et al*. (2023).

These findings support the use of sodium azide as an effective mutagen for inducing genetic variability, which is crucial for crop improvement programs. While the mutagenesis treatment resulted in increased variability, the degree of change varied across accessions. This highlights the importance of carefully selecting accessions for mutagenesis based on their potential for improvement in key agronomic traits. Similar studies on induced mutations in *African yam bean* show that such variability can be used to identify favorable mutants for breeding purposes, as in the case of *Sphenostylis stenocarpa*, where mutation breeding enhanced traits such as seed set and plant height (Olawuyi & Ajie, 2023; Olawuyi *et al*., 2023)

Characterization of Mutants

The characterization of mutants revealed that sodium azide treatment produced phenotypic alterations in several accessions, most notably in NGB00701, which displayed improvements in plant height, leaf length, and number of leaves. The increase in leaf size and stem diameter in NGB00701 suggests that this accession could be a promising candidate for breeding programs aimed at improving yield and stress resistance. Conversely, the limited changes in NGB02626 suggest that not all accessions are equally responsive to sodium azide treatment, and that genetic background plays a significant role in determining mutagenic response. These findings align with other studies, including those on *African yam bean*, where the genetic background of accessions influenced their response to mutagenesis, with some accessions exhibiting improved traits and others showing limited or no response (Olawuyi *et al*., 2023). Similarly, Olawuyi & Okoli (2017) reported that in maize, sodium azide-induced mutations revealed significant genetic variability in growth and agronomic traits, with some genotypes showing higher tolerance and yield improvements.

CONCLUSION

Sodium azide mutagenesis effectively induced *Capsicum* accessions showing genetic variability with notable improvements in growth traits observed in some accessions. The response to mutagenesis was accession-dependent, highlighting the importance of selecting appropriate accessions for mutagenesis. The induced variability in traits such as plant height, leaf size, and number of leaves could be beneficial for breeding programs aimed at enhancing yield and environmental stress tolerance. More importantly, accessions NGB00703, NGB002642 and NGB00701 which performed best could be improved for breeding programs of *Capsicum* species. Future studies should also focus on identifying the molecular mechanisms underlying the observed phenotypic changes and explore the potential of sodium azide-induced mutants for improving *Capsicum* spp. for agricultural purposes.

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