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EFFECT OF SODIUM AZIDE ON GERMINATION AND SEED MORPHOLOGICAL TRAITS OF SELECTED COWPEA (*Vigna unguiculata* [L.] Walp.) VARIETIES IN MAKURDI

Chikete, J. T. M., Ochigbo, A. E. and **Ugbaa S. M.**[1]
Department of Plant Breeding and Seed Science,
Joseph Sarwuan Tarka University Makurdi, Beneue State-Nigeria.

Ojo, G. O. S.
Department of Crop Production
Joseph Sarwuan Tarka University Makurdi, Beneue State-Nigeria.

Correspondence: jerrychikete@gmail.com

Abstract
This experiment was designed to determine the effect of sodium azide on germination and seed morphological traits of cowpea varieties in Makurdi. Three Cowpea varieties of UAM09-1055-6, IT99K-573-1-1 and UAM09-1051-1, were treated with sodium azide at increasing mutagen concentrations of 0.01 %, 0.02 %, 0.03 %, 0.04 % and control to obtain M_1 for field evaluation. The experience was done at Joseph Sarwuan Tarka University Research Farm and the experimental design was Randomized Complete Block Design with three replications. Data were collected on number of pods / plant, pod length, number of seeds/pod, seed length, seed width, 100seed weight, seed yield, final germination percentage, germination index and mean germination time. The result showed significant differences for both morphological seed traits and germination parameters. Also there were increased concentration and decreased germination. Concentration effect and interaction indicated highly significant difference ($p<0.05$) between mutants and the control. Varietal effect showed no significant difference ($P<0.05$) in number of pods per plant and pod length. 0.01% dose of sodium azide induced increased pod length, 100 seed weight, seed length and seed yield. 0.02% induced increased seed width, pod width and number of pods per plant. The control recorded highest number of seeds per pod. For germination parameters, 0.01% sodium azide concentration effectively influenced all the traits measured except mean germination time; while 0.03% concentration showed least effect except in mean germination time. This may be due to healthy interaction between the mutagen and the DNA of the living cell. Thus, in mutation breeding, lower doses of sodium azide are suitable for inducing positive seed morphological traits in cowpea.

Keywords: Cowpea, Germination, Morphological traits, Mutation Breeding, Sodium azide

Introduction
Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most important food and forage legumes in the semi-arid tropics that include parts of Asia, Africa, Southern Europe, Southern United States, and Central and South America (Ochigbo *et al.,* 2018). It is a member of the *Phaseoleae* tribe of the *Leguminosae* family, and among the most important versatile and nutritive grain legumes native to Africa (Timko *et al.*, 2007). Due to its tolerance for sandy soil and low rainfall, it is an important crop in the semi-arid regions across Africa and Asia (Dugje *et al.*, 2009). Cowpea requires very few inputs, as its root nodules are able to fix atmospheric nitrogen to the soil, making it a valuable crop for resource-poor farmers. The seeds are a major source of plant proteins and vitamins for man, feed for animals, and also a source of cash income for rural farmers. The young leaves and immature pods are eaten as vegetables (Dugje *et al.*, 2009). Cowpea can adapt to a wide range of environmental conditions and cropping systems in West Africa (Duke, 1981).

According to Food and Agriculture Organization Corporate Statistical Database (2021), Africa accounts for the majority of the world's cowpea production (96.7 %), with Nigeria being the largest producer (~3.6 million tons in 2019). The global production area of cowpea was estimated at 14.5 million ha with an annual production of 6.2 million metric tons (Kebede and Bekeko, 2020) of dried grain and an average potential yield of 1.5 to 6 MT per ha (Peace, 2015). West Africa, with 10.48 to 10.7 million ha, represents 75 % of Africa's production (Ochigbo *et al.,* 2018). Nigeria produces cowpea grains annually at approximately 2.14 million metric tons to 3.02 million tons (Ochigbo *et al.,* 2018). In Benue State, located in the Southern Guinea Savanna of Nigeria, 272,270 metric tonnes of cowpea were produced from over 300,000 hectares of land in 2009. Production in Benue is very low usually (0.3 - 1.0 t/ha) as small-scale farmers use traditional system of mixed intercropping with maize, sorghum, millet, yam, cassava, pepper and other vegetable crops (Dugje *et al*., 2009). The crop plays a very important role in achieving food security due to its high nutritional content of 23 – 30 % protein, 50 – 67 % carbohydrate, 1.9 % fat, 6.35 % fiber and small percentage of the B-vitamins such as folic acid, thiamine, riboflavin and some micronutrients (Iron, Phosphorus, Zinc and Calcium) that improve human nutrition and health status (Chinma *et al*., 2008; and Sefa-Dedeh *et al*., 2011). Cowpea is an indispensable ideal crop which the Millennium Developmental Goals could use to reduce poverty and hunger, improving human health and nutrition, and enhancing environmental friendly ecosystem.

Breeding for sustainable crop improvement depends to a large extent on the availability and accessibility of intra-specific genetic diversity of crop plants. Genetic variation is the fuel for adaptation under artificial or natural selection, and ultimately this has its origin in mutation (Keightley, 2004). Induced mutations have been used to improve major crops like wheat, rice, and other seed propagated crops. Various mutagenic agents are used to induce favorable mutations at high frequency that include ionizing radiation and chemical mutagens (Ahloowalia and Maluszynski, 2001). Chemical mutagens are the one cause of mutations in living organism (Yuan and Zhang, 1993). These effects can occur both spontaneously and artificially following induction by mutagens. These chemo mutagens induce a broad variation of morphological and yield structure parameters in comparison to normal plants (Khan *et al*., 2009). Chemical mutagenesis (the non-GMO approach) is a simple approach to create mutation in plants for the improvement of potential agronomic traits (Adamu and Aliyu, 2007). Sodium azide (NaN_3) is a chemical mutagen and has been one of the most powerful mutagens in crop plants (Wen and Liang, 1995).

The variability of the existing cowpea varieties is low due to self-pollinating nature of this crop, narrowing the genetic resources for development of plant cultivar. The rate of spontaneous mutation is naturally low (Dorvlo *et al.,* 2022), making artificial induction an appropriate option and a quick method of enhancing genetic variability in crop plants through induced mutation (Nair *et al.,* 2014). Regional preferences occur for seed size, color and texture of seed coat resulting in the rejection of varieties lacking the farmers / consumers' choice for economic and agronomic gains in Nigeria and the world at large (Egbadzor *et al*., 2014; Boukar *et al.,* 2018). Mutation breeding is a recognized valuable tool for crop improvement, yet, induced mutation has been least applied in grain legumes (Bado *et al.,* 2015). Information on cowpea mutation breeding and mutant cultivars particularly on seed morphological mutations in Nigeria is scarce (Olasupo *et al.,* 2016). The adoption of strategic research in cowpea aimed at breeding the best varieties that meet farmers need, facilitate food security and poverty reduction is necessary (Van Duivenbooden *et al.*, 2002). Varying preferences of cowpea in terms of morphology and seed type implies the need to develop varieties with suitable characteristics across agro-ecological zones (Mashi *et al.,* 2006). Inducing and incorporating mutant genes into old cultivars to suit modern agronomic practices is attainable (Pathirana, 2011). Sodium azide has been successfully used to generate genetic variability in groundnut, barley and other crops (Mensah and Obadoni, 2007). Thus, mutations induction in seed morphological traits can be exploited to create variability on which selection could be based for breeding improved cowpea varieties with farmer desired traits. Equally, investigating the effect of mutagens on germination parameters of cowpea will provide a basis for choice of mutagen dose of sodium azide that will not be lethal for germination of mutants. The objective of this study therefore was to assess (i) the effect of Sodium azide on the yield and seed morphological traits of M_1 of selected cowpea varieties (ii) identify effective concentration of sodium azide for mutagenic reaction in seed morphological traits of cowpea (iii) determine the effect of Sodium azide on germination parameters of M_1 of selected cowpea varieties.

Materials and Methods

The experiment was conducted during the 2020 cropping season at Teaching and Research Farm of the Joseph Sarwuan Tarka University, Makurdi Benue State, Nigeria. The site is situated in the Southern Guinea Savannah Ecological zone of Nigeria at Latitude 7 ^{0}41″N and Longitude 8^0 28′E with an elevation of 97m above sea level and has well drained sandy loam soil. Makurdi is characterized by a tropical climate with two distinct seasons, the wet or rainy season and the dry season. The wet season starts from April and ends in October with an annual rainfall in the range of 1500 mm to 1800 mm. The dry season begins in November and ends in March (Ochigbo, 2017). Three cowpea genotypes namely UAM09-1055-6, UAM09-1051-1 and IT99K-573-1-1 were obtained from the Molecular Biology Laboratory of the Joseph Sarwuan Tarka University Makurdi and Sodium azide of analytical grade was obtained from a chemical store.

Seed treatment and bioassay: Clean and good healthy-looking seeds were selected across the three genotypes of cowpea on the basis of diverse yield performance and pod maturity period and soaked in distilled water which was 10 times their volume for three hours after a floatation test to determine seed viability. The seeds were removed from water and air dried for one hour thirty minutes after which they were soaked in mutagenic solution of sodium azide prepared in plastic beakers according to their respective doses of 0.01%, 0.02%, 0.03%, 0.04% and a control (untreated) for three hours. The solution was drained thereafter and the seeds thoroughly washed under clean running water for thirty minutes. Ten seeds per treatment were immediately placed in fresh and labelled petri dishes containing moistened cotton wool. The petri dishes were placed in an aerated well lit area of the laboratory and observed for germination. Data was taken daily from observation made from the experiment. The number of germinated seeds were recorded daily and at the end of the experiment, the mortality rate was estimated and recorded. The treated seed lots were taken to the field for planting. The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated three times. A total area measuring 76 m x 15 m was used for the experiment. Land was prepared manually and ridges made using traditional implements. 4 seeds were planted per hole in a plot of 4×3 m² at a depth of 2-3 cm in an intra-row spacing of 25 cm and inter-row spacing of 75 cm with 10 plant stands on each ridge, after which a pre-emergence herbicide (pendimethalin) was applied at a dilution of 150 ml per 20 litres 0f water in

knapsack sprayer to subdue weeds until crop establishment. Seeds were thinned to two plants per stand at 2 weeks after planting.
Insects and pests were controlled by applying “karate" (Lambda-cyhalothrin) at the rate of 2 litres/ha (dilution of 100 ml per 20- litres of water) at budding, flowering and podding stages and Imiforce also was applied at the rate of 30 ml in 20-litres of water to control aphids. Application of the pesticide was done 14 days after planting using Knapsack sprayer and subsequently repeated at 7 days interval until pods were matured. Weeds were controlled manually 21 days after planting and subsequently as the need arose. Nitrogen, Phosphorus and Potassium were applied in the form of NPK 15:15:15 fertilizer at the rate of 100 kg/ha with an equivalence of 0.075kg (75g) per plot, applied by band placement as a single dose at one week after planting. A total of fifteen treatment combinations comprising of three cowpea varieties and five sodium azide concentration doses were used for this study is shown below.

$T_1 = V_1SAD_0$	$T_6 = V_2SAD_0$	$T_{11} = V_3SAD_0$
$T_2 = V_1SAD_1$	$T_7 = V_2SAD_1$	$T_{12} = V_3SAD_1$
$T_3 = V_1SAD_2$	$T_8 = V_2SAD_2$	$T_{13} = V_3SAD_2$
$T_4 = V_1SAD_3$	$T_9 = V_2SAD_3$	$T_{14} = V_3SAD_3$
$T_5 = V_1SAD_4$	$T_{10} = V_2SAD_4$	$T_{15} = V_3SAD_4$

KEY: V = Cowpea Varieties; V_1 = UAM 09-1055-6; V_2 = IT99k-573-1-1; V_3 =UAM 09-1051-1; SAD = SODIUM AZIDE DOSE; D_0 = CONTROL; D_1 = 0.01%; D_2 = 0.02%; D_3 = 0.03% and D_4 = 0.04%.

Data Collection

Quantitative and qualitative data were collected from plants on each treatment and observations were recorded on the following traits: Number of pods per plant, pod length (cm), number of seeds per pod, Seed length (cm), 100 Seed weight (g), yield (Kg/ha), pod curvature of mature pods, pod wall thickness, Seed shape, Testa texture, seed/testa colour, final germination percentage, germination Index, mean germination time (MTG).

Statistical Analysis

Data on yield and its components, as well as on germination parameters were subjected to analysis of variance (ANOVA), using Minitab version 17 software and implemented using G.L.M procedure. Statistically significant means were separated using Tukey pair wise comparison at the probability level of $P \leq 0.05$.

Results and Discussion

Table 1 shows mean performance of the main effect of variety on measured traits. Among the varieties studied, UAM09-1055-6 showed superior performance than the other varieties for the parameters measured as it produced the highest values for pod length (15.97cm), number of seeds per pod (10.21), seed yield (1342 kg / ha), seed length (1.30 cm) and seed width (2.01 cm) which were significantly different ($P < 0.05$) from those of UAM09-1051-1 variety. UAM09-1051-1 produced the least values in all the measured traits except number of pods / plant in which it produced the highest value (29.57), however, this has no significant difference from the values produced by IT99K-573-1-1 (27.93) and UAM09-1055-6 (27.93) varieties.

Generally, IT99K-573-1-1 was the next in performance to UAM09-1055-6 variety in terms of superior variety means as it relates to all the parameters evaluated for varietal effects of the cowpeas varieties studied except for number of pods / plant where it had same mean value with UAM09-1055-6 (27.93).

This results indicated that there were highly significant difference (P<0.05) among the varieties in all the seed traits measured except in number of pods per plant and pod length.

Table 2 shows the mean performance of the main effect of concentration of sodium azide on measured traits. Among the chemical concentrations, 0.02 % dose induced the highest number of pods per plant (32.18 cm) and seed width (2.18 cm). The value for the trait number of pods per plant was significantly difference at (P < 0.05) from the control (16.79 cm) but not statistically different from other dose levels, with the least value produced by the control. The value for the trait seed width showed significant difference (P < 0.05) from the control and other dose levels, however, there was no significant variation between the values from 0.01 % (2.01 cm) and 0.02 % concentration. 0.01 % concentration of sodium azide (NaN_3) induced the highest pod length (17.16 cm), grain yield (1384 g) and seed length (1.31 cm). The value for the trait pod length showed significant difference at (P < 0.05) from the control (9.61cm), it however did not statistically vary from other dose levels. Grain yield was statistically different (P < 0.05) from the control and other dose levels. Seed length was not statistically different (P < 0.05) from 0.02 % and 0.03 % dose levels but was significantly different from 0.04 % (1.24 cm) and the control (0.88 cm). The concentration 0.04 % of NaN_3 induced the highest 100 seed weight (23.09 g) which was statistically different (P < 0.05) from the control and the other levels except 0.01 % (22.94 g).

Table 3 present the interaction effect of variety x sodium azide concentration on seed morphological traits of Cowpea. From the table, 0.02% dose induced the highest number of pods per plant (39.13) in UAM 09-1051-1 which was not significantly different at (P < 0.05) from 0.01 % dose for UAM09-1051-1 (38.63) that was next highest in value with the least produced by the control for IT99K-573-1-1 (22.33) which was statistically different (P < 0.05) from the other treatments.

The highest pod length (19.17cm) was induced by 0.01 % dose of sodium azide in UAM09-1051-1. This was statistically different at (P < 0.05) from 0.04 % dose for UAM09-1051-1 but not in significant variance with the control from same variety which recorded the second highest value (18.40 cm). The least pod length was produced by the control in IT99K-573-1-1 (13.63cm).

The control for UAM09-1055-6 produce the highest number of seeds per pod (10.80), which did not statistically vary at (P < 0.05) from 0.03 % dose for UAM09-1055-6, it however varied significantly from the other treatments.

Table 1: Main Effect of Variety on Measured Traits

Variety	Number of Pods / plant	Pod length (cm)	Number of Seeds / Pod	100 seed weight (g)	Seed yield (kg/ ha)	Seed length (cm)	Seed width (cm)
UAM09-1051-1	29.57	14.54	7.43	17.31	1331	1.03	1.73
IT99K-573-1-1	27.93	14.66	9.06	23.06	1336	1.29	1.96
UAM09-1055-6	27.93	15.97	10.21	19.01	1342	1.30	2.01
LSD (0.05)	4.11	1.34	0.52	0.66	3.35	0.03	0.14

Table 2: Main Effect of Concentration on Measured Traits

Concentration	Numbers of Pod/plant	Pod length (cm)	Number of Seed/Pod	100seed weight(g)	Seed yield (kg/ha)	Seed length (cm)	Seed width (cm)
0.00	16.79	9.61	6.72	13.32	1359.00	0.88	1.36
0.01	29.90	17.16	9.55	22.94	1384.00	1.31	2.01
0.02	32.18	15.50	9.09	19.30	1342.00	1.28	2.18
0.03	31.30	16.24	10.11	20.32	1306.00	1.29	1.99
0.04	31.16	16.78	9.02	23.09	1290.00	1.24	1.97
LSD (0.05)	5.30	1.72	0.67	0.84	4.32	0.03	0.18

0.01 % dose for UAM09-1051-1 (38.63) that was next highest in value with the least produced by the control for IT99K-573-1-1 (22.33) which was statistically different ($P < 0.05$) from the other treatments.

The highest pod length (19.17cm) was induced by 0.01 % dose of sodium azide in UAM09-1051-1. This was statistically different at ($P < 0.05$) from 0.04 % dose for UAM09-1051-1 but not in significant variance with the control from same variety which recorded the second highest value (18.40 cm). The least pod length was produced by the control in IT99K-573-1-1 (13.63cm).

The control for UAM09-1055-6 produce the highest number of seeds per pod (10.80), which did not statistically vary at ($P < 0.05$) from 0.03 % dose for UAM09-1055-6, it however varied significantly from the other treatments.

Table 3: Interaction Effect of Variety x Sodium Azide Concentrationon Seed Morphological Traits of Cowpea

Treatment	Numbers of Pod/plant	Pod length (cm)	Number of Seed/Pod	100seed weight(g)	Seed yield (kg/ha)	Seed length (cm)	Seed length (cm)
UAM 09-1051-1							
Control	35.90	18.40	8.98	20.23	1268.80	1.22	1.22
0.01	38.63	19.17	8.97	22.97	1289.10	1.30	1.30
0.02	39.13	16.60	8.88	20.83	1055.53	1.29	1.29
0.03	34.17	18.53	10.30	22.53	988.53	1.31	1.31
0.04	0.00	0.00	0.00	0.00	0.00i	0.00	0.00
IT99K-573-1-1							
Control	22.33	13.63	9.34	20.97	1250.50	1.31	1.31
0.01	24.60	16.07	9.17	28.20	1253.30	1.35	1.35
0.02	29.57	14.23	9.76	20.83	1040.23	1.29	1.29
0.03	30.53	14.73	9.26	17.67	1014.77	1.26	1.26
0.04	29.47	14.63	7.74	27.40	981.10	1.19	1.19
UAM 09-1055-6							
Control	28.03	15.20	10.80	19.00	1257.43	1.32	1.32
0.01	26.47	16.23	10.50	17.67	1144.80	1.28	1.28
0.02	27.83	15.67	8.64	16.32	1028.53	1.27	1.27
0.03	29.20	15.47	10.75	20.77	1014.50	1.30	1.30
0.04	28.10	17.30	10.34	21.63	997.67	1.31	1.31
LSD (0.05)	9.192	2.99	1.16	1.464	7.48	0.05	0.05

Number of seeds per pod was least induced by 0.04 % dose for IT99K-573-1-1 (7.74) which was significantly different ($P < 0.05$) from the control and the other treatments.

For 100 seed weight, 0.01 % of NaN_3 for IT99K-573-1-1 induced the highest value (28.20 g) which was statistically different from other treatment except 0.04 % of NaN_3 for IT99K-573-1-1. The least 100 seed weight was induced by 0.02 % of NaN_3 for UAM09-1055-6 (16.23 g).

Highest grain yield (1289.10) was induced by 0.01 % of NaN_3 in UAM09-1051-1 which was significantly different at ($P < 0.05$) from the other dose levels and also the control from same variety which produced the second highest grain yield. The least of grain yield was induced by 0.04 % of NaN_3 for IT99K-573-1-1 (981.10) where 0.04 % dose of NaN_3 for UAM09-1051-1 recorded no value.

For the trait seed length, 0.01 % of NaN_3 IT99K-573-1-1 induced the highest seed length (1.35cm) with high significant difference at ($P < 0.05$) from the control of UAM09-1055-6 (1.32cm) which was next in value. Least seed length was induced by 0.04 % of NaN_3 for IT99k-573-1-1 (1.19cm) which was statistically different from the other treatments.

Highest seed width (2.45cm) was induced by 0.02 % of NaN_3 UAM09-1051-1 which was statistically different at ($P < 0.05$) from other treatments including the controls, but was not statistically different from 0.01 % UAM09-1051-1 (2.17cm) which produced the second highest value (2.17 cm) for seed width. The least seed width was induced by 0.04 % of NaN_3 for UAM 09-1055-6 (1.81 cm).

Table 4 shows the mean performance from the effect of Sodium Azide on germination studied for evaluated characters of M_1 mutant of Cowpea. Among the chemical concentration used in this study, T_{02} (0.01 %) of NaN_3 induced the most effective final germination percentage (58.89 %) which was highly significantly different at ($P < 0.05$) from T_{05} (0.04 %) of NaN_3 which was next highest in value. The least final germination percentage was induced by T_{04} (0.03 %) of NaN_3 (24.44 %) which statistically vary ($P < 0.05$) from the control T_{01}.

The most effective germination index (321.11) was induced by T_{02} (0.01%) of NaN_3 which was significantly different ($P < 0.05$) from T_{05} (238.89), the second highest in value. The least germination index was induced by T_{04} (0.03 %) of NaN_3 (86.67) which was statistically different ($P < 0.05$) as compared to the control (86.67).

Table 4: Effect of Sodium Azide on Germination of M_1 Mutant of Cowpea

Chemical Conc.	FGP	GI	MTG
T_{01} (0.00)	35.56^{c}	162.78^{c}	17.69^{b}
T_{02} (0.01)	58.89^{a}	321.11^{a}	5.33^{d}
T_{03} (0.02)	32.22^{cd}	134.44^{cd}	18.53^{b}
T_{04} (0.03)	24.44^{d}	86.67^{d}	22.43^{a}
T_{05} (0.04)	46.67^{b}	238.89^{b}	12.96^{c}

Means followed by the same letter within a column are not significantly different from each other ($P < 0.05$)

Key: FGP - Final Germination Percentage, GI - Germination Index, MTG - Mean Germination Time.

The parameter mean germination time indicated the highest value in T_{04} (0.03 %) of NaN_3 (22.43) which was statistically different ($P < 0.05$) from the other concentration levels and the control. T_{03} (0.02 %) of NaN_3 was next in value (22.43) to $T_{04.}$ The least mean germination time was induced by T_{02} (0.01 %) of NaN3 (5.33) which was statistically different ($P < 0.05$) as compared with the control. However, there was no significant difference between the T_{03} (18.53) and the control (17.69).

Effect of Sodium Azide on seed Morphological Traits of M_1Mutant on Cowpea

The results showed that there were highly significant difference ($P<0.05$) among the varieties in all the seed traits measured except in number of pods per plant and pod length. This result is in close agreement with the earlier reports of Bala *et al.* (2006) who stated that the differences observed in most of the quantitative and qualitative traits among the mutants showed significant improvement in the selected traits. A highly significant difference ($P<0.05$) was observed among the concentration in the entire seed traits measured. This could be due to abiotic factors such as pH, Temperature, time and concentration of mutagen, which are responsible to determine the efficiency of mutant production (Sable *et al.,* 2018). The results further showed that there were highly significant variation ($P<0.05$) among the interaction (variety concentration) in the entire morphological seed traits evaluated. This was in agreement with the observation of Eze and Dambo (2015), where they reported that all the traits and nutritional composition were significantly affected by sodium azide treatment; this significance difference ($P<0.05$) brought genetic variability among varieties studied, such genetic variability could be due to abiotic factors such as pH, temperature, time, and concentration of mutagen that determined the effectiveness of mutant production or it could be due to physiological factors.

Among all the sodium azide treatments used in this study, 0.01% dose of IT99k-573-1-1 resulted to an increased 100 seed weight and seed length and also increased pod length and seed yield in UAM 09-1051-1. With an increase in the concentration, 0.02% of UAM09-1051-1 showed an increase in number of pods/plant and seed width. This agrees with the report of Shorma *et al.* (2010).

With an increased concentration of sodium azide (NaN_3), 0.04 % dose showed a decrease in seed length, number of pods/plant and number of seeds per pod. This result agrees with the observation of Adamu and Aliyu (2007) who shared that almost all the morphological and nutritional traits were decreased with increase concentration of sodium azide for the two maize varieties studied.

Among the UAM 09-1051-1, 0.02 % performs more effectively in inducing an increase in number of pods/Plant and seed width, whereas 0.04 % dose showed the least performance. In IT99K -573-1-1, the result indicated that 0.01 % dose induced an increase in 100 seed weight, seed yield, and seed length. This increase was significantly different at ($P<0.05$) as compared to the control. This result agreed with the observation of Mustapha *et al*. (2021), who reported that dry weight of 100 seed were also found to increase in sam -15 variety (Table 3).

Among the varieties, UAM 09-1055-6 showed an outstanding performance in all the seed traits evaluated except number of pods/plant and 100 seed weight while IT99k-573-1-1 showed the highest performance in 100 seed weight. UAM 09-1051-1 showed the least performance except number of Pods/plant.

Effect of Sodium Azide on Germination of M_1Mutant of Cowpea

The results showed that there were highly significant differences (P<O .05) among the varieties and chemical concentration on all the germination parameter in this study, T_2(0.01% of NaN_3) was found to be very effective which resulted to induce mutation in all the germination parameters measured except for mean germination time (MTG). This was in agreement with the observation of Amol *et al.* (2018), who reported that all the five treatment of sodium azide had effective increase on germination when compared with the control. T_4 (0.03% of NaN_3) resulted in reducing all the germination parameters except for mean generation time (MTG). This was in agreement with the observation of Eze and Dambo (2015), which reported the mutagenic treatment resulted in reduction in seeding height, plant height at maturity, ear length, and ear width. Such a reduction might be due to toxicity of the mutagen on physiological parameters. The reduction in seed germination in mutagenic treatment has been explained due to the delay or inhibition of physiological and biological processes necessary for seed germination inducing enzymes activity (Olise *et al.,* 2019).

Conclusion

Mutation breeding is one of the popular breeding methodologies to create non existing variations in crops, chemical mutagens have proven to be extremely useful to create new allelic variants that can be used in plant breeding, Sodium azide (NaN_3) has been reported to be one of the most useful mutagens in crop plants and it has been found to bring about mutagenic effects and plant improvement. The result showed that there was highly significant difference ($p<0.05$) in the effect of various concentration of Sodium azide on the morphological seed trait.

The variety showed significant difference ($P<0.05$) in all the parameters except number of pods per plant and pod length. These significant differences were observed between the mutant seeds and the control for both morphological seed traits and the germination parameters measured.

Among the sodium azide, 0.01% played the most effective role in inducing an increased pod length, 100 seed weight, seed length and seed yield while 0.02% was effective in inducing an increased number of pods per plant and seed width. The highest number of seeds per pod was recorded from the control. All the germination parameters were affected by sodium azide. 0.01% showed the most effective performance in all the traits measured except in mean germination time (MTG). However, 0.03 % responded poorly as it showed the least performance in all the germination parameters except in mean germination time (MTG).

Recommendation

The conclusion showed that low dose Sodium azide performs better in inducing useful mutation in cowpea. It is therefore recommended that low dose of Sodium azide such as 0.01% should be used in mutation breeding of cowpea for seed morphological traits which may be useful in seed sorting, seed grading and crop improvement.

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