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Mutagenic effects of sodium azide on some qualitative traits of maize (*Zea mays*)

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Abstract

This research was conducted to determine the effects of sodium azide on some quantitative traits of maize varieties namely: Hakorin hajiya (local variety) and Sam-15 variety (improve variety). The seeds were presoaked in distilled water for six hours, and transferred into various concentrations (0.00%, 0.01%, 0.02% and 0.03%) of sodium azide for another six hours. The research was arranged in complete randomized design with two varieties, four treatments and three replicates. Number of days of germination ware reduced, seeds survival also noticeably affected, early tasseling and sulking in lower concentration was observed while higher concentration take more days compared with control. The weight of 100 dried seeds increased with increase in concentration in sam-15 variety, and decreasing with increase in concentration in hakorin hajiya variety.

Keywords: *Variety, Mutation, Maize, Sodium azide*

1. Introduction

Mutation refers to the sudden change in the genetic make-up of an organism. Chemical mutagenes serve as a simple way to create mutation in plants for their improvement of potential agronomic traits (Khan *et al.*, 2009). Mutation breeding has been used in well-adapted plant varieties to upgrade them by altering some of their major agronomic traits which might hinder their productivity or enhance their quality (Roychowdhury and Tah, 2011). It has been used to improve agricultural crops such as maize, wheat, black gum, rice, barley, peanut, etc. According to Ahloowalia and Maluszynski (2001) various mutagenic such as chemical mutagens and ionizing radiation agents are used to induce favorable mutations at high frequency (Ahloowalia and Maluszynski, 2001). Choosing an effective mutagen is crucial when looking for desirable traits in plant. Therefore, in this study, sodium azide was used because Mostafa (2011) recommended that it is one of the most powerful chemical mutagens in crop plants. It is relatively safe to handle, very efficient, inexpensive and non-carcinogenic (Salvi *et al.*, 2014). Many studies reported that sodium azide was successfully used to assess genetic variability in plant breeding (Mostafa, 2011; Kulthe and Kothekar, 2011; and Aurabi *et al.*, 2012). Drought stress resistance has been improved from –0.0021 MPa to –0.0077 MPa using sodium azide

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(Aurabi *et al.*, 2012). According to Salim *et al.* (2009) the developmental phenomena of plants were mostly affected by disturbing their metabolic activities using mutagens. Several new varieties with good traits were generated by breeders when chemical mutagens were used as they induce chromosomal aberrations at a rate much lower than other mutagens (Dubey *et al.*, 2017). Abiotic factors such as pH, temperature, time and concentrations of mutagens determined the efficiency of mutants' production (Sable *et al.*, 2018). Maize is an annual plants which belong to family Poaceae and Genus *Zea* (Mustafa *et al.*, 2013). It is cross-pollinated, monoecious plant in which the male and female flowers are located in different inflorescences on the same stalk (Gnanamurthy *et al.*, 2011). It has an overlapping sheaths and broad conspicuously distichous blades. It has 10 pairs of chromosome. It is the only species in the genus *Zea* of the Poaceae family that is of economic importance (Mustafa *et al.*, 2013). It is important in human nutrition, and basic requirements of animal feed as well as raw material for manufacturing of various products such as corn oil, fermented products and recently, biofuel (Olakojo, 2004; Olawuyi *et al.*, 2013; and Olawuyi *et al.*, 2015).

Hence, the present study focused on the "Effect of Sodium azide on two varieties of maize namely: Hakorin hajiya (local variety) and Sam-15 (Improved variety)" is proposed with the following objectives:

1) To study the effect of sodium azide on seed germination at different concentrations.
2) To study the morphological variation between different varieties of maize at different concentrations.

2. Materials and methods

2.1. Study area

The experiment was conducted in Botanical Garden of the Department of Biological Sciences, Gombe State University, Gombe State, Nigeria in 2017.

2.2. Seed collection

Two varieties of maize were used in the present study: Hakorin hajiya (local variety) and Sam-15 (improved variety). The former was collected from Tudun Hatsi cereal market Gombe and the later was from the Department of Agronomy, Ministry of Agriculture Gombe, Gombe state.

2.3. Seed treatments

The procedure of Olawuyi and Okoli (2017) was adapted with little modification. The seeds were pre-soaks in distilled water for six hours. They were later treated with different concentrations of sodium azide: 0.00%, 0.01%, 0.02% and 0.03%. Another set of seeds were used as control treatment. The treatment was periodically checked and the procedure was conducted at room temperature. After the duration of the treatments, the seeds were washed thoroughly in running tap water for 5-8 times.

3. Experimental design

The research was arranged in complete randomized designed with two varieties, four treatments and three replications ($2 \times 4 \times 3$).

4. Data collection

Number of days to 50% germination: Seedling survival was obtained six (6) days after planting by counting the number of surviving seedling per treatment and their percentages were recorded.

Number of leaves: The number of leaves per plant were determined by counting the number of leaves at vegetative, maturity and reproductive stage, their mean values were recorded.

Plant height: The plant height was determined by measuring the height of the plants from the soil level to the tip of the highest leaf using meter rule at vegetative, maturity and reproductive.

Number of days to tasseling: The number of days it took from the day of planting to the day of the first appearance of tassels for each treatment was recorded by counting the days.

Cob(s) length (cm) and width (cm): The length and width of the cob(s) were measured using tape.

Seed weight (g): After harvesting, hundred (100) seeds weight was determined weighing balance and average was recorded.

5. Statistical analysis

The data collected was subjected to Analysis of Variance (ANOVA) to compare the means and Duncan Multiple Range test was used to rank the various parameters for the different treatment at $p = 0.05$ level of significance.

6. Results

The results from the study shows that various concentration of sodium azide has effects on some quantitative traits of *Zea mays*.

Table 1 shows the effects of sodium azide on germination and survival of seed. For the germination, number of days for germination were observed to be reduced at various concentrations (0.00%, 0.1%, 0.02% and 0.03%) from 6 to 5 days in hakorin hajiya variety and 7 to 5 days in Sam-15 variety, and for the survival of seeds, both varieties were negatively affected in all concentrations used.

Table 1: Effects of sodium azide on seed germination

Variety	Treatments	Days to germination	Seed survival
Hakorin hajiya	0.00%	7.67^{a}	4.00^{a}
	0.01%	5.00^{a}	3.67^{a}
	0.02%	5.00^{a}	3.00^{a}
	0.03%	5.00^{a}	3.33^{a}
Sam-15	0.00%	6.00^{a}	4.00^{a}
	0.01%	5.00^{a}	3.33^{a}
	0.02%	5.00^{a}	3.00^{a}
	0.03%	5.00^{a}	3.00^{a}

Note: Values with similar superscripted alphabet(s) within a column indicate that there is no significant different ($p > 0.05$), while those with different superscripted alphabet(s) are significantly different ($p < 0.05$).

Table 2 shows the effects of sodium azide on some growth parameters like number of leaves and height at vegetative, reproduction and maturity using different concentrations (0.00%, 0.01%, 0.02% and 0.03%) of the

Table 2: Effects of sodium azide on some growth parameters

VAR	TRT	NLV	NLM	NLR	HV	HM	HR
H. hajiya	0.00%	16.34^{a}	27.67^{a}	32.67^{a}	55.22^{ab}	147.67^{a}	188.33^{a}
	0.01%	15.55^{a}	28.33^{a}	31.67^{a}	56.33^{ab}	140.33^{a}	172.67^{a}
	0.02%	15.00^{a}	29.00^{a}	31.33^{a}	52.78^{b}	153.00^{a}	163.33^{a}
	0.03%	18.89^{a}	34.00^{a}	33.67^{a}	65.89^{a}	153.67^{a}	178.67^{a}
Sam-15	0.00%	14.44^{a}	26.33^{a}	23.00^{a}	50.72^{b}	135.00^{b}	154.00^{a}
	0.01%	13.11^{a}	22.33^{ab}	23.67^{a}	49.78^{b}	136.67^{ab}	174.67^{a}
	0.02%	13.67^{a}	20.00^{b}	22.67^{a}	54.00^{ab}	144.33^{ab}	184.33^{a}
	0.03%	13.89^{a}	21.00^{b}	23.00^{a}	58.33^{a}	153.33^{a}	180.33^{a}

Note: Values with similar superscripted alphabet(s) within a column shows no significant different ($p > 0.05$), while those with different superscripted alphabet(s) are significantly different ($p < 0.05$); and KEY: VAR: Variety, TRT: Treatments, NLV: Number of leaves at vegetative, NLM: Number of leaves at maturity, NLR: Number of leaves at reproductive, HV: Height at vegetative, HM: Height at maturity, HR: Height at reproductive.

chemical mutagens on two verities of maize (hakorin hajiya and sam-15 variety). Number of leaves, at vegetative stage for both varieties were significantly reduced ($p < 0.05\%$) in all concentrations used, at maturity, there is significant ($p < 0.05\%$) increase with increased in concentrations in hakorin hajiya variety compares to control used, but in sam-15 variety there were more leaves observed in control compares to all the concentrations used, this shows that, the chemical affected the number of leaves at sam-15 variety at maturity. For the number of leaves at reproductive stage, there was little improvement at higher concentration in hakorin hajiya variety, but other lower concentrations shows negative effects as compares to control used, in sam-15 variety little improvement was observed at lower concentration while the higher concentration shows no effects. At height, there was significant improvement at higher concentrations in both varieties, but the height at reproductive stage in Hakorin hajiya was decreasing with increased in concentrations used and for sam-15 variety there was an increased in height with increased in concentrations.

Table 3 shows the effects of chemicals mutagens on days to tasseling, sulking and some yield parameters including: cob length, cob width and the weight of 100 seeds. For the tasseling appearance, there were reductions in the number of days to tasseling in the lower concentrations used in both varieties, but higher concentration in hakorin hajiya variety shows there was no significant different ($p > 0.05\%$). while significant different observed in sam-15 variety ($p < 0.05\%$). At lower concentration, reduction in the number of days for sulking was observed in both hakorin hajiya and sam-15 variety, while negligible different was observed at higher concentrations in the former, delayed sulking in the later. Increase in length and width of the cobs were also observed with increase in concentrations in hakorin hajiya variety, but sam-15 variety shows increase with lower concentration and decrease with higher concentration compared to control. The weight of 100 seeds were also found to increase with increase in concentration in sam-15 variety, while decreasing with increase in concentration in hakorin hajiya variety.

Table 3: Effects of sodium azide on days to tasseling, sulking and some yield parameters

VAR	TRT	DT	DS	CL (cm)	CW (cm)	100 SW (g)
H. hajiya	0.00%	73.67^{a}	78.33^{a}	11.37^{c}	10.63^{b}	14.44^{b}
	0.01%	65.67^{b}	69.00^{c}	13.63^{b}	11.37^{b}	20.46^{a}
	0.02%	65.33^{b}	68.00^{c}	13.20^{b}	11.10^{b}	19.70^{a}
	0.03%	72.00^{a}	76.00^{b}	15.40^{a}	13.47^{a}	15.50^{b}
Sam-15	0.00%	59.33^{b}	64.00^{a}	12.30^{b}	10.80^{b}	15.87^{d}
	0.01%	54.00^{c}	59.00^{b}	15.57^{a}	12.17^{ab}	19.04^{c}
	0.02%	52.33^{c}	55.00^{c}	13.52^{b}	12.67^{a}	21.97^{b}
	0.03%	62.67^{a}	67.00^{a}	10.67^{b}	10.67^{b}	24.00^{a}

Note: Values with similar superscripted alphabet(s) within a column indicate that there is no significant different ($p > 0.05$), while those with different superscripted alphabet(s) are significantly different ($p < 0.05$); and KEY: DT: Days to tasseling, DS: Days to sulking, CL: Cob length, CW: Cob width, SW: Seed weight.

7. Discussion

It has been realized that rapid industrialization and urbanization are among the ways of achieving accelerated economic growth. Nevertheless, this may causes many other challenges that include lack of arable land which might subsequently lead to food shortage. Maize is considered to be one of the most economic and valuable agricultural commodity in many parts of the world because it has a good adaptability towards a wide range of soil and climate. Induced mutation technology for crop improvement has become an increasing important area of research over the last few decades (Dubey *et al*., 2017).

Based on the results obtained in the present study, the number of days of germination were reduced from 6 to 5 days in hakorin hajiya variety and 7 to 5 days in Sam-15 variety, this is in agreement with the result of Lal *et al*. (2009) who reported that general reduction in seed germination was observed. However, this finding

differ with that of the Pavadai and Dhanavel (2004), Gnanamurthy *et al.* (2012) and Eze and Dambo (2015) there report was that sodium azide induced late germination in maize compare to the control. The seed survival was also affected with different concentrations of sodium azide and was noted to decreased with increase in concentration, which is in accordance with the findings of Lal *et al*. (2009), Eze and Dambo (2015) and Ali *et al*. (2014). Plant height in the present study shows that, there is a significant ($p < 0.05\%$) improvement at higher concentrations in both varieties, this is in line with the result of Banu *et al.* (2005). But the height at reproductive stage in local variety was reduced with increase in the concentration of sodium azide as can be found in black gram by Deepalakshmi and Anandakumar (2004) and in cowpea by Rizwana *et al.* (2005).

Lower concentrations of sodium azide in the present study induced early tasseling and sulking, while higher concentrations delayed tasseling and sulking. So many results buttressed our finding using different crops such as soybean by (Pavadai and Dhanavel, 2004), Bhendi by (Sasi *et al.,* 2005) and cowpea by (Girija 2008), Gnanamurthy *et al.* (2012), maize by Eze and Dambo (2015). With respect to yield parameters, mutagens showed an improvement compared to control of both varieties. This results also is in line with that of the Ahloowalia and Maluszynski (2001) who reported that, induced mutation has great potentials and serves as a complementary approach to genetic improvement of crops such as wheat, rice, barley, cotton, peanut, and cowpea, which are seed propagated. The dry weight of 100 seeds were also found to increase with increase in concentration in sam-15 variety, this agrees with the assertion of Sharma *et al.* (2010), who reported that the effectiveness and efficiency of mutagenic in general increase with the increasing mutagen dose. Some variations exits between the present study and several others, this might probably because of the concentrations used, pH, soil type varieties used and the time.

8. Conclusion

The present study revealed the effectiveness of sodium azide as chemical mutagens, which is more effective particularly at lower concentration inducing many desirable traits. Therefore, these morphological traits induced in the present study might be used as an agronomical desirable traits which may be possibly utilized in future breeding program in maize.

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