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Research Article

Mutagenic Effects of Sodium Azide on the Quality of Maize Seeds

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Abstract: This project was conducted to determine the mutagenic effects of sodium azide on the quality of maize seed. Maize seeds were treated at six different concentrations of sodium azide namely; 0.00mM, 0.01mM, 0.02mM, 0.03mM, 0.04mM and 0.05mM. The seeds that were treated were of two varieties namely; Sammaz 18 and Sammaz 20. The result obtained showed that sodium azide was effective in causing mutagenic change in the quality of maize seeds in terms of growth rate and seed size. Significant differences ($P<0.05$) were observed in all the two varieties with respect to some of the traits studied and nutritional compositions studied. The number of days to 50% flowering and Nitrogen-free extract (%) increased significantly with an increase in concentrations of sodium azide. Chlorophyll-deficient mutants were observed in treatments 0.02mM, 0.03mM and 0.04mM which were striata and light green in colour. Dwarfed mutant was also recorded in treatment 0.04mM of Sammaz 20 maize variety. The project was carried out to find out the effectiveness of sodium azide on the mutagenesis of maize seeds, seed weight of mutant maize plant, nutrient content of the mutant maize plant and the morphological features of the mutant maize plant. I recommend that chemical mutagens like sodium azide to produce improved seed varieties like of maize plants that will meet the present global and national food need.

Keywords: Mutation, Mutagen, Mutagenic, Sodium Azide, Mutants, Maize, Varieties, and Nutrients.

1. Introduction

Mutation can be defined as the change in the genetic material of an organism which is heritable (Gardner *et al*., 1991). Mutations are the tools used to study the nature and functions of genes which are the building blocks and the basis of plant development, thereby producing raw materials for the genetic improvement of economic crops (Adamu and Aliyu, 2007). Mutation methodology has been used to produce many cultivars with improved value and study of genetics and plant development phenomenal (Van *et al*., 1990) and (Bretagne-Sagnard *et al*., 1996). It has been demonstrated that genetic variability for several desired characters can be induced successfully through mutation and its practical value in plant improvement programs has been well established. The main advantage of mutation breeding is the possibility of improving one or two characters without changing the rest of the genotype. 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. Various mutagenic agents are used to induce favorable mutations at high frequencies that include ionizing, radiation and chemical mutagens (Ahloowalia and Maluszynski, 2001). Chemical mutagens are one cause of mutation in living organisms. Many of such chemicals have clastogenic (chromosome damaging) effect on plants via reactive oxygen-derived radicals (Yuan and Zhang, 1993). These effects can occur both spontaneously and artificially the following induction by mutagens. Chemical mutation generally produces induced mutation which leads to base pair substitution, especially GC-AT resulting in amino acid change, which changes the function of proteins but does not abolish their functions as deletions or frameshift mostly do (Van, 1996). These chemo-mutagens induce a broad variation of morphological and yield structure parameters in comparison to normal plants. Many researchers compared the mutagenic efficiencies of different mutagens on different crops and their results seem to be entirely specific for particular species and even variety. Many researchers have found chemical mutagens to be more effective than physical ones (Rao and Rao, 1983) other researchers found the reverse case (Tarar and Dnyansagar, 1980).

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Sodium azide (NaN_3) is a chemical mutagen and has been found to be one of the most powerful chemical mutagens that and decreases cyanide resistance, respiration in tobacco callus (Wen and Liang, 1995). It is known to be highly mutagenic in several organisms, including plants and animals (Rines, 1985) and its mutagenic potential has been reported in many screening assays. Sodium azide is marginally mutagenic in different organisms (Jones *et al*., 1980) and it is not known in several organisms mutagenic in others, such as Drosophila and Arabidopsis (Kamra and Gollapudi, 1979; Gichner and Velemínský, 1977). The mutagenicity is mediated through the production of an organic metabolite of azide compound (Owais and Kleinhofs, 1988) this metabolite enters into the nucleus, interacts with DNA and creates a point mutation in the genome. Being a strong mutagen in a plant, it affects the different part of the plant and their growth development phenomena by distributing the metabolic activity.

Plant breeding is the science and art of changing the genetic composition of the plant for the improvement of desired traits, quality or character. It is a means of developing new plant varieties for cultivation and use by humans. Plant breeding requires genetic variation of useful traits for crop improvement. Genetics became a science of plant breeding after the Moravian monk J.G. Mendel discovered the laws of heredity in the mid-19th century. Plant breeding uses the method of heredity (segregation and assortment laws of Mendel), hybridization which combines various desirable properties of many plants in one and the method of germplasm derived from induced mutation. However, modern attempts in plant breeding involve the use of other techniques like mutation breeding and biotechnology (Genetic Engineering) which are also used in breeding crops that reproduce vegetatively like bananas, apples, cassava, and sugarcane (Novak and Brunner, 1992).

The concept of mutation breeding, mutagenesis and genetically modified organisms have become more popular in recent times because it has been found to be an effective tool in breeding of new and improved varieties of plants and animal species with better yield, nutrient, quality, resistance to pests and diseases (Acharya *et al*., 2007) and an efficient means of supplementing existing germplasm for cultivar improvement in breeding program's (Dubinin, 1961). Induced mutations are highly effective in enhancing natural genetic resources and have been used in developing improved cultivars of cereals, fruits and other crops (Lee *et al*., 2002). This area of science can still be explored in order to tackle present human, animal and plant challenges such as drought or food scarcity, sickness and diseases, climate change and its effect, industrialization, scarcity of land or urbanization, etc. (Maluszynski *et al*., 2000). Mutation breeding will help to meet the global need for food, especially corn or maize food which is consumed in Nigeria and it has great potentials in the alleviation of malnutrition among resource poor farmers, making it extremely valuable where many people cannot afford protein foods such as meat and fish (Gnanamurthy *et al*., 2012).

Food scarcity is a global challenge that is currently facing many countries, especially the developing countries of the world. There is, therefore, a need to improve on the existing food crops to meet this global need. Genetically Modified Food is the most viable scientific means that can be used in improving food crops like maize seed to meet the need for more food considering other limiting factors of crop and food production like climate change, pest, diseases, and the availability of land due to urbanization especially in this time of global food scarcity as a result of the geometric increase in world human population. Considering the global scarcity of food and the need for food crops with greater yield, quality, and resistance to disease and pest it has become necessary to improve upon the existing maize variety to meet the main food need (Novak and Brunner, 1992). It is documented by Ulmalkar *et al*., (1998) and Fernandez-Martinez *et al*., (1993) that chemical mutagens like sodium azide has been found to be one of the most powerful mutagens in crop plants. It has been reported that sodium azide affects plant physiology and decrease cyanide-resistant respiration in tobacco callus (Wen and Liang, 1995). Sodium azide can, therefore, be used to produce maize that has improved yield, seed quality and that will meet the food need of our country and the rising human population (Waghmare and Mehra, 2000).

2. Materials and Methods

2.1 Study Area

The study was conducted in the Biological Garden of the Department of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria. Zaria is located on Latitude 110 11'N and Longitude 07038'E with elevation above sea level as 613m (2011ft). There are two main seasons in Zaria namely; dry season, which lasts from October to April and the rainy season which lasts from May to September.

2.2 Seed Collection

Two varieties of maize (*Zea mays* L.) seeds were collected, Sammaz 18 and Sammaz 20-white from the Department of Plant Science, Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria.

2.3 Proximate Composition of Seeds

Proximate analysis was carried out at the Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University; Zaria uses the method described by AOAC, (1990) for each of the seed varieties to determine the nutrient content in the seed before treatment with sodium azide and at the end of the experiment.

2.4 Experimental Design

Seeds were soaked in water in groups of eighty per treatment for 6 hours, after which they were treated with Sodium azide for another 6 hours. They were immersed in 200ml of the sodium azide at the following concentrations; 10mM, 20mM, 30mM, 40mM, and 50mM. 50mls of Phosphate buffer pH 3 was added to each of the treatment to maintain the sodium azide pH at 3. Another set of seeds was also soaked in distilled water and buffer (pH 3) as a control treatment. The treatments were periodically agitated and the procedure was conducted at room temperature. After the duration of the treatments, seeds were thoroughly rinsed with a running tap water for about 8 to 10 times. After thorough rinsing, the seeds were then arranged on double layers of filter papers in Petri dishes for viability study. Viability study was carried out by observing the seeds with the naked eyes and selecting those seeds that look healthy and without cuts or bruises. Immediately after the viability study, five seeds of the different varieties for each treatment and control were sown in a polythene bag in groups of five bags per treatment. The 5 seeds sown for each treatment was duplicated or replicated once. The planting layout that was used was Completely Randomized Design.

2.5 Data Collection

2.5.1 Germination count: Germination count was conducted five days after planting when the coleoptiles have emerged from the soil for both control and treated seed and their percentages were calculated for each treatment.

2.5.2 Seedling survival: Seedling survival was obtained 30 days after germination by counting the number of surviving plants per treatment and their percentages were calculated.

2.5.3 Seedling height and root length: Seedling height and root length were taken after 30 days of planting using meter rule. Measurements were taken from the base of the plant to the highest leaf on the plant for seedling height and from the soil level on the plant to the tip of the longest for root length. The average height and root length were taken for comparison among treatments and control.

2.5.4 Height at Maturity: Plants heights were measured from the soil level to the tip of the highest leaf using meter rule. This was done to determine the effect of Sodium azide on plant height before the date of harvesting.

2.5.5 Survival to Maturity: The number of plants that survived to maturity in each treatment was counted and their percentages were calculated. This was done to compare injury induced by various treatments when compared to the number of seeds planted in the control.

2.5.6 Number of days to 50% flowering: The number of days it took from the day of planting to the day of the first appearance of tassels and 50% flowering was recorded for each treatment.

2.5.7 Number of cob(s) per plant: The numbers of cob(s) per plant were counted after the plant had fruited.

2.5.8 Ear Length (cm) and Ear Width (cm): The ear length and width of the cobs was measured using a measuring tape calibrated in centimeters.

2.5.9 Chlorophyll deficient mutant: Chlorophyll deficient mutants were observed on the basis of their different coloration and the observations were taken after germination. Such mutants were recorded and discussed in the result.

2.5.10 Mean Seed weight (Kg): After harvesting, the mean fresh weights of the seeds for each treatment were taken and the mean dry weights were also taken on the weighing scale after drying the seed in the oven at a temperature of 30^0C to 40^0C.

2.5.11 Root Length at Maturity (cm): The root length at maturity was measured on the day of harvesting using a measuring tape calibrated in centimeters by measuring the length of the longest root.

2.5.12 Seed nutrient: The quality of the seed will be determined using proximate analysis to determine the various food nutrients contained in the seed and their percentage presence in comparison with the control.

2.6 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 5% or $P = 0.05$ level of significance.

3 Results

The result obtained from this study is presented in Tables 1-6.

Table 4 shows the mean square estimate of the effect of sodium azide on maize. The result indicated significant differences ($P<0.05$) for all traits studied except for germination count (%), seedling height (cm), seedling root length (cm), survival at maturity, number of days to 50% flowering, number seedling leaf, number of plant leaf and root length at maturity which showed no significant difference in the two varieties of maize treated with sodium azide in the M1 generation. Table 5 and Table 6 show the Mean effect of sodium azide on the performance of the two varieties Sammaz 18 of maize was significantly different in seedling survival, number of cob per plant, number of days to 50% flowering, ear length, ear width, Fresh weight, dry weight while Sammaz 20 showed significant difference in mean of germination count (%), number of days to 50% flowering, seedling survival, number of cob(s), ear length (cm), ear width (cm), fresh weight (Kg) and dry weight (Kg).

4. Discussion

The results from the study showed all the traits and nutritional compositions were significantly affected by sodium azide treatment except seedling height, seedling root length, height at maturity, survival at maturity, number of days to 50% flowering, number of seedling leaf, number of plant leaf at maturity and root length at maturity. Almost all the morphological and nutritional traits were decreased with increased concentrations of sodium azide for the two maize varieties studied. All the mutagenic treatments resulted in reduction in seedling height, plant height at maturity, ear length, ear width, fresh weight and dry weight in the F1 generation. This is in accordance with the result obtained by Pugalendi (1992) in Sesame and Adamu *et al*., (2002). With respect to germination and seedling growth rate, sodium azide produced many effects, including inhibition and delayed germination. Many works have also reported such a dose/concentration dependent inhibition of seed germination for different crops. Ramaswamy (1973) in Black gram; Jagadeeswaran (1989) in groundnut: (Shamsi *et al*., 1981) in Sunflower and Pavadai and Dhanavel (2004) in Soybean. The reduction was more pronounced in 0.05mM such as a reduction might be due to the toxicity of mutagens on physiological parameters. Similar results were obtained by Odeigah *et al*., (1998). All the mutagens showed an increase in the number of days to 50% flowering. A delay of first tasselling and silking was observed at higher concentration of sodium azide (50mM). Similar results have been observed in different crops Soybean (Pavadai and Dhanavel, 2004), Bhendi (Sasi *et al*., 2005) and Cowpea (Girija, 2008). Ricardo and Ando (1998) also reported that combined treatment of gamma radiation and sodium azide on M2 generations of *Oryza sativa* there was a delay in number of days to flowering compared to the control. The plant height at maturity was reduced with an increase in the concentration of sodium azide as reported in black gram (Deepalakshmi and Anandakumar, 2004) and in Cowpea (Rizwana *et al*., 2005). Adamu (2004) has also reported a decrease in seedling plant heights and root length of popcorn (*Zea mays* var. Praecox Sturt.) with increase in gamma rays and thermal neutrons. Similar results had earlier been reported by Singh *et al*., (1991), who stated that seedling survival was dose dependent. The least number of seedling survival observed in the highest concentration of sodium azide as well as percentage lethality is in conformity to the findings of Bird and Neuffer (1988) who found that with increase in gamma-ray dose, there was a decrease in seedling survival of grass pea and maize. The control matured earlier than the treated seeds as also reported by Jordan and Ramani (1991). The failure of the highest concentration (0.04mM and 0.05mM) in sodium azide treatment to produce cob(s) in some plants is similar to the report of Gramatikova and Todorov (1996). The chlorophyll deficient mutants observed in 0.02mM, 0.03mM and 0.04mM were in agreement with the findings of Hagberg (1962) who reported high frequency of chlorophyll-deficient mutants in the M2 generation of barley treated with sodium azide.

5. Conclusion

Sodium azide has been found to bring about a mutagenic effect in maize plants. The seed weight of the mutant seeds of the two varieties was compared with that of the control and the difference was found to be significant with the statistical value of $P<0.05$. The nutrient content of the mutant seeds of each treatment shows significant difference when compared with the nutrient content of the control. Significant difference was also observed in some of the morphological features that were studied in the mutant seeds of each treatment and the control. 0.05mM and 0.04mM played the most important role in improving the quantitative and qualitative traits of maize (*Zea mays*). The treatment of 0.02mM of sodium azide produced the best yield in terms of vigour and size of all the treatments in the two maize varieties studied. I recommend that maize seeds treated with sodium azide should be used to create beneficial mutants of other maize varieties and other crops. There is also need to conduct more researches on M2, M3, etc. generations to confirm the isolating effect of any particular mutant. More researchers should also be conducted concurrently with other traits such as disease resistance, pest resistance, environmental stress and other important agronomic characters in other to improve maize production, especially in Nigeria to meet the food need of the growing population.

Table 1. Mean square estimate of effect of sodium azide on maize (Sammaz 18).

Source of variation	Degree of freedom	Germination count per bag %	Number of days to germination	Seedling survival %	seedling height (cm)	Seedling root length (cm)	Height at maturity (cm)	Survival to maturity %	Number of days to 50% flowering	Number of cob per plant	Number of seedling leaf	Number of plant leaf at maturity	Ear length (cm)	Ear Width (cm)	Mean fresh weight (kg)	Mean dry weight (kg)	Root length at maturity (cm)
Treatment	5	913.33	1.55	1120.00	56.48	5.42	1245.33	388.49	33.00	0.55	0.13	1.33	15.28	2.73	1085.25	237.88	101.08
Error	6	500.00	0.08	66.67	163.75	4.19	1500.83	1737.12	21.00	0.25	0.17	4.17	0.00	0.00	0.00	0.00	85.58
F. Value		1.83	18.60	18.60	0.34	1.29	0.83	0.22	1.57	2.20	0.80	0.32	5.82	2.46	∞	71365.00	1.18
LOS		ns	*	*	ns	ns	ns	ns	ns	*	ns	ns	*	*	*	*	*

Note: LOS = level of significance ($p<0.05$) and * = significant

Table 2. Mean Effect of Sodium Azide on two Varieties of Maize (*Zea mays L.*).

VAR	TRT	GC	NDG	SS	SH	SRL	HM	SM	NDF	NC	NSL	NPL	EL	EW	MFW	MDW	RLM
SAMMAZ 18	0.00mM	60.00^{a}	3.00^{b}	80.00^{a}	82.00^{a}	19.00^{a}	127.00^{a}	51.50^{a}	59.50^{a}	2.00^{a}	6.50^{a}	10.50^{a}	17.00^{c}	6.00^{b}	32.00^{c}	14.40^{d}	51.00^{a}
	0.01mM	60.00^{a}	5.00^{a}	60.00^{a}	73.00^{a}	18.50^{a}	131.50^{a}	34.34^{a}	68.00^{a}	1.50^{ab}	6.50^{a}	9.00^{a}	21.00^{a}	7.00^{a}	72.10^{a}	31.90^{a}	38.00^{a}
	0.02mM	50.00^{a}	5.00^{a}	40.00^{b}	67.00^{a}	16.00^{a}	62.50^{a}	17.17^{a}	59.50^{a}	0.50^{b}	7.00^{a}	9.00^{a}	20.00^{b}	7.00^{a}	39.20^{b}	21.70^{b}	30.50^{a}
	0.03mM	30.00^{a}	5.00^{a}	30.00^{b}	74.50^{a}	17.25^{a}	103.00^{a}	17.17^{a}	67.00^{a}	1.00^{ab}	7.00^{a}	9.00^{a}	16.00^{e}	4.50^{d}	26.00^{e}	9.40^{e}	46.50^{a}
	0.04mM	50.00^{a}	5.00^{a}	70.00^{a}	79.00^{a}	17.00^{a}	111.00^{a}	34.34^{a}	60.50^{a}	1.00^{ab}	7.00^{a}	9.50^{a}	16.30^{d}	5.00^{c}	30.30^{d}	18.70^{c}	39.50^{a}
	0.05mM	10.00^{a}	5.00^{a}	20.00^{b}	72.00^{a}	14.50^{a}	96.00^{a}	17.67^{a}	66.50^{a}	1.50^{ab}	7.00^{a}	8.00^{a}	13.50^{f}	4.50^{d}	0.00^{f}	0.05^{f}	40.00^{a}
SAMMAZ 20	0.00mM	90.00^{a}	3.00^{b}	100.00	84.00^{a}	29.50^{a}	144.00a	34.84^{a}	58.00^{a}	2.00^{a}	7.00^{a}	11.00^{a}	26.00^{a}	8.00^{a}	90.60^{a}	48.50^{a}	40.00^{a}
	0.01mM	30.00^{b}	5.00^{a}	50.00^{b}	72.00^{a}	30.00^{a}	113.50^{a}	34.34^{a}	61.00^{a}	1.50^{ab}	7.00^{a}	10.50^{a}	12.00^{f}	5.50^{d}	14.80^{d}	7.10^{c}	40.50^{a}
	0.02mM	50.00^{b}	5.00^{a}	50.00^{a}	76.00^{a}	30.50^{a}	122.50^{a}	33.84^{a}	62.00^{a}	1.00^{b}	7.00^{a}	11.00^{a}	13.50^{e}	6.50^{b}	17.10^{c}	4.90^{e}	42.50^{a}
	0.03mM	40.00^{b}	5.00^{a}	40.00^{bc}	64.50^{a}	27.50^{a}	103.00^{a}	17.67^{a}	61.50^{a}	1.00^{b}	6.50^{a}	11.00^{a}	19.00^{c}	4.00^{e}	0.00^{e}	0.00^{e}	42.00^{a}
	0.04mM	20.00^{b}	5.00a	20.00^{c}	69.50^{a}	30.50^{a}	121.00^{a}	17.67^{a}	65.00^{a}	1.00^{b}	7.00^{a}	6.00^{a}	23.00^{b}	6.00^{c}	29.50^{b}	17.70^{b}	31.00^{a}
	0.05mM	20.00^{b}	5.00^{a}	30.00^{bc}	68.50^{a}	24.50^{a}	123.50^{a}	34.34^{a}	61.50^{a}	1.00^{b}	7.00^{a}	10.00^{a}	17.00^{d}	4.00^{e}	17.10^{c}	5.30^{d}	47.00^{a}

NOTE: a,b,c,d,e = SIGNIFICANCE and means with the same letter(s) in the column are not significant ($P<0.05$). GC= Germination count per bag (%), NDG= Number of Days to Germination, SS= Seedling Survival (%), SH= Seedling Height (cm), SRL= Seedling Root Length (cm), HM= Height at Maturity (cm), SM= Survival To Maturity (%), NDF= Number of Days To 50% Flowering, NC= Number of Cob Per Plant, NSL= Number of Seedling Leaf, NPL= Number of Plant Leaf AT Maturity, EL= Ear Length (Cm), EW= Ear Width (cm), MFW= Mean Fresh Weight (Kg), MDW= Mean Dry Weight (Kg), RLM= Root Length At Maturity (cm).

Table 3. Mean Square Estimate of Effect of Sodium Azide on Maize (Sammaz 20).

Source of variation	Degree of freedom	Germination count per bag %	Number of days to germination	Seedling survival %	Seedling height (cm)	Seedling root length (cm)	height at maturity (cm)	Survival to maturity %	Number of days to 50% flowering	Number of cob per plant	Number of seedling leaf	Number of plant leaf at maturity	ear length (cm)	ear width (cm)	Mean fresh weight (kg)	Mean dry weight (kg)	Root length at maturity (cm)
Treatment	5	139.33	1.55	1553.33	93.48	11.15	366.95	148.41	10.00	0.35	0.08	7.68	58.48	4.73	2046.67	642.40	55.60
Error	6	233.33	0.08	100.00	93.92	147.42	572.92	1557.83	16.83	0.08	0.08	0.75	0.00	0.00	0.00	0.00	103.17
F. Value		5.97	18.60	15.53	1.00	0.08	0.64	0.10	0.59	4.20	1.00	10.24	∞	∞	∞	∞	0.54
LOS		*	*	*	NS	NS	NS	NS	NS	*	NS	NS	*	*	*	*	NS

NOTE: LOS = LEVEL OF SIGNIFICANCE ($P<0.05$); * = SIGNIFICANT and NS = NOT SIGNIFICANT

Table 4. Mean Square Estimate of Effect of Sodium Azide on the Nutritional Composition of Maize Seed (Sammaz 18).

VARIETY	DEGREE OF FREEDOM	DRY MATTER %	CRUDE PROTEIN %	CRUDE FIBER %	OIL %	ASH %	NITROGEN FREE EXTRACT %
TREATMENT	5	2936.47	24.41	4.18	2.19	5.37	2282.46
ERROR	6	0.00	0.00	0.00	0.00	0.00	0.00
F-VALUE		∞	2.06	∞	∞	1.27	7.53
LOS	*	*	*	*	*	*	*

NOTE: LOS = LEVEL OF SIGNIFICANCE ($P<0.05$) and * = SIGNIFICANT

Table 5. Mean Effect of Sodium Azide on the Nutritional Composition of two Maize Varieties (*Zea Mays L*).

VARIETY	TREATMENT	DRY MATTER %	CRUDE PROTEIN %	CRUDE FIBER %	OIL %	ASH %	NITROGEN FREE EXTRACT %
SAMMAZ 18	0.00mM	94.78^{a}	8.95^{a}	4.56^{a}	4.20^{a}	5.18^{a}	77.11^{e}
	0.01mM	93.86^{c}	8.63^{c}	2.29^{c}	3.81^{e}	1.64^{c}	83.63^{d}
	0.02mM	93.56^{d}	8.13^{d}	2.27^{d}	3.93^{d}	1.87^{b}	83.80^{c}
	0.03mM	93.04^{e}	8.13^{d}	2.29^{b}	4.01^{c}	1.59^{d}	83.96^{a}
	0.04mM	94.00^{b}	8.75^{b}	2.04^{e}	4.06^{b}	1.22^{e}	83.93^{b}
	0.05mM	0.00^{f}	0.00^{e}	0.00^{f}	0.00^{f}	0.00^{f}	0.00^{f}
SAMMAZ 20	0.00mM	94.56^{a}	9.02^{a}	3.86^{a}	4.08^{a}	5.41^{a}	77.63^{e}
	0.01mM	93.56^{c}	8.81^{e}	3.08^{b}	3.98^{c}	1.82^{b}	82.31^{d}
	0.02mM	93.29^{d}	8.94^{c}	2.56^{d}	3.77^{e}	1.78^{c}	82.95^{b}
	0.03mM	0.00^{e}	0.00^{f}	0.00^{f}	0.00^{f}	0.00^{f}	0.00^{f}
	0.04mM	93.29^{d}	9.00^{b}	4.04^{c}	4.04^{b}	1.55^{e}	82.50^{c}
	0.05mM	93.78^{b}	8.88^{d}	3.87^{e}	3.87^{d}	1.59^{d}	83.22^{a}

NOTE: a,b,c,d,e = SIGNIFICANCE and means with the same letter(s) in the column are not significant (P<0.05).

Table 6. Mean Square Estimate of Effect of Sodium Azide on the Nutritional Composition of Maize Seed (Sammaz 20).

VARIETY	DEGREE OF FREEDOM	DRY MATTER %	CRUDE PROTEIN %	CRUDE FIBER %	OIL %	ASH %	NITROGEN FREE EXTRACT %
TREATMENT	5	2926.75	26.59	3.44	5.22	6.43	2234.74
ERROR	6	0.00	0.00	0.00	0.00	0.00	0.00
F-VALUE		4.29	5.61	∞	3.53	∞	2.95
LOS	*	*	*	*	*	*	*

NOTE: LOS = LEVEL OF SIGNIFICANCE (P<0.05) and * = SIGNIFICANT

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