MUTAGENIC EFFECT OF SODIUM AZIDE (NaN3) CONCENTRATIONS AND SEASONAL VARIATIONS ON SOME GROWTH PARAMETERS ON THREE VARIETIES OF TOMATO (LYCORPERSICON ESCULENTUM MILL.)

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Abstract – The impact of Sodium Azide induced mutation methods on the growth and yield of three varieties of tomato were investigated with the aim of inducing variability that could be exploited in the improvement of some quality traits in Tomato plants. Three different treatments (chemical mutagenesis via sodium azide,) were applied on to the three tomato varieties. The seeds of three varieties of tomato: Roma, UC and Local varieties were treated at four different concentrations of Sodium azide (NaN3) (0.1mM, 1.0 mM, 2.0 mM and 0.0 mM as control) after which some of the mutants were not treated with the mutagen. The result obtained revealed highly significant difference (P≤0.01) in the effects of sodium azide on survival rates, number of fruits and number of seeds per fruit. Similarly, highly significant differences (P≤0.01) were observed between the treatments in Survival rate, except on the number of fruits and number of seeds where no significant differences exist. Significant difference was found in the traits between the seasons except in fruit number. The result developed that activities sodium Azide improves important quality traits of tomato. A concentration of 0.1 mM of Sodium Azide improve some important quality traits of tomato that could be utilized for further improvement of tomato crop. However, the response of variety UC to sodium Azide was higher. It was concluded that, sodium Azide via mutation improves some important quality traits of tomato that are of high economic value and possible recommendations made.

Keywords: Sodium Azide, Variation, Season, Concentration, Tomato. Parameters.

INTRODUCTION

The cultivated tomato (*Lycopersicon esculentum*Mill.) which belongs to the family Solanaceae considered as the second most important vegetable crop in the world after potato.(Adamu, *et: al.,* 2007). Tomato ranks third among vegetable crops with an annual production of 283 million metric tons in the year 2009.(Mehandjiev *et: al,*.2001*)*. Tomato have a nutritional and medicinal value for its content from vitamin A and C.(Haq, *et: al.,* 2011) beside carotenoids pigments content is considers as an antioxidant protect humans body from free radicals damages and reduce the risk of getting cancer and also cholesterol free. Tomato sometime rightly referred to as poor man's orange.(El- Khaaby, *et: al.,* 2012).

It belongs to the small genus *Lycopersicon* consisting of nine species within the large family *Solanaceae* (Mann *et al*., 2003). It is nowadays one of the major vegetable crops cultivated throughout the world and is grown in a wide range of environments comprising natural and protected conditions (Dhaliwal *et: al.,* 2002) of both the tropical, sub-tropical and temperate parts of the world.

The cultivated tomato is an annual herb with different growth habits comprising of erect, prostrate or climbing stems (Gill, 1992). The stem can be determinate or indeterminate with reddish to yellowish glandular hairs having monopodial branching system. The root is of tap-root system. The leaves are opposite and pinnately compound with lobed margins which are ovate to oblong and petiolated. The flowers form raceme inflorescence, perfect, actinomorphic and pentamerous with superior ovary. The fruit is a berry with smooth skin which is reddish to yellowish succulent at maturity and many seeded. The seeds are flat and kidney shaped (Johnson, 2005).

Tomato *(L. lycopersicum* Mill.) is a plant with variety of uses. The importance of the plant is mostly centered upon its edible fruits (Mann *et al*., 2003). The fruit is rich in alkaloid tomatine, lycopene, carotene, ascorbic acid and

vitamins (Gill, 1992). The seeds, leaves and skin can provide oil on extraction that can be used as cooking oil. The fruit is used for making soup and sausage (Johnson, 2005).

The plant is of high medicinal importance as the fruit is a good remedy for preventing or inhibiting various forms of venous and arterial thrombosis and fibrin clots formation in veins. It is a valuable food mineral and vitamins particularly vitamin A and C. Studies have shown that people who ate tomatoes or tomato products may be at lower risks of some kind of cancer, particularly cancer of the prostate gland, lungs and stomach(Encarta, 2005. The fruits are recommended for patients suffering from obesity, hormone replacement therapy, anti phospho-lipid syndrome, cancer or patients suffering from genetic and plasmic risk factors as well as those that had recently undergone surgical operations. (Encarta, 2005).

Despite all the tremendous importance of tomato, little importance has been put into the improvements of its genetic diversity to meet the demand of the local populace in Nigeria. There is lack of proper attention given to the improvement of this plant to prevent its seizure at some period of the year to reduce its risen cost by both the governments and the scientific community.

Mutations are the tools used by the geneticist to study the nature and function of genes which are the building blocks and basis of plant growth and development, thereby producing raw materials for genetic improvement of economic crops (Adamu *et: al,*. 2004). Induced mutations have great potentials and served as a complimentary approach in genetic improvement of crops (Mehandjiev *et: al.,* 2001). The mutants so produced facilitate the isolation, identification and cloning of genes used in designing crops with improved yields, increase stress tolerance, longer shelf life and reduced agronomic input (Ahloowalia &Maluszynski 2001). This study aimed to investigate The Impact of Sodium Azide concentrationand seasonal variations on some growth parameters of three varieties of tomato (*Lycopercon esculemtum Mill.*)

MATERIALS AND METHOD

The research was conducted in the Green House of the Botanical Garden of the Department of Biological Sciences, Ahmadu Bello University Zaria, Kaduna State. (Lat11^0 12^{1}N, Long 7^0,37^{1}E, Alt 550-700 m. above sea level). (Anonymous, 2014).

Sources of the Seeds

Seeds of three varieties of cultivated tomato (*Roma*, *UC*82B and *local variety*) were collected from the Institute for Agricultural Research (I.A.R), Ahmadu Bello University Zaria, Kaduna state, Nigeria.

Treatment and Experimental Design

The treatments used in the research are Grafting and mutation using various concentrations of sodium Azide. The seeds of the three tomato varieties were soaked//treated with three different concentrations of Sodium Azide (0.1mM, 1.0mM, 2.0Mm) for 4hours while 0.0mM as control. The plants were grown in 45 polythene bags arranged in a Completely Randomized Design (CRD) with three replications each. A total of 370 plants were raised.

The remaining was left as control as described in McVoy (2005) protocol.

Data Collection

Data were obtained from number of Survival rate and number of fruits/plant, were observed and recorded. During the data collection, the survival rate, number of fruits/plants and number of seeds /fruit were observed and recorded as follows:

Survival Rate (%)

The number of grafts that survive during the emergence of first flower were determined and their percentages taken. Leafless grafts were regarded as dead.

Number of Fruits/Plant

The number of fruits produced per plant was determined through counting per treatment per variety after twelve weeks of planting and recorded.

Number of Seeds/Fruit

The number of seeds produced per fruits was determined by counting after the fruits were cut open by a razor blade.

Data Analysis

Data analysis was carried out and all the data obtained were analyzed using Analysis of Variance (ANOVA). Mean were separated using Duncan's Multiple Range Test. (DMRT).

RESULTS

The results from the combined analysis of variance on the effects of sodium Azide on some selected traits of three tomato varieties are presented in (Table 1) The results showed highly significant difference (P≤0.01) in the effect of concentrations of sodium azide on all the selected tomato traits. .More so, highly significant difference (P≤0.01) was found among the seasons in terms of seeds number. Significant difference (P≤0.05) was found among the seasons on survival rate, while no significant difference was found among the seasons in terms of fruits number.

However, no significant difference in the interactions of sodium azide with varieties and between sodium azide on all the selected traits of the three tomato varieties. Similarly, no significant difference was found in the interactions of sodium azide with seasons in almost all the selected traits, where the effects of the interaction is highly significant (P≤0.01) and on seeds number. However, highly significant difference (P≤0.01).Significant difference (P≤0.05). More so, highly significant difference (P≤0.01) was found in the interaction of varieties with seasons on almost all the selected traits of tomato varieties except on seeds number, where no significant difference was found.

However, no significant difference was found in the interaction of sodium azide concentrations with varieties and interaction of sodium azide with varieties and seasons on the selected traits of the tree tomato cultivars. More so, no significant difference was found in the interaction of varieties and seasons on the selected tomato traits except on seeds number where highly significant difference (P≤0.01) was found.

Table 1: Mean Squares for the Combined Effects of Sodium Azide on Some Varieties of Tomato in Two Different Seasons

Sources of Variation	df	Survival Rate (%)	Number of Fruits	Number of Seeds/Fruit
Replication	2	74.54^{ns}	11.87*	476.72*
Concentration	3	14265**	188.59**	5594**
Variety	2	3803.53**	37.26**	2892**
Seasons	1	874.67*	0.01^{ns}	6868.16**

Conc. x Var	6	44.73^{ns}	3.19^{ns}	76.59 ^{ns}
Conc. x Seasons.	3	35.35^{ns}	0.91^{ns}	359.19*
Var. x Seasons	2	4860.2**	95.56**	117.05 ^{ns}
Conc. x Var x Seasons	6	9.13^{ns}	9.88^{ns}	99.76 ^{ns}
Error	142	148.56	2.78	105.50

Keys: ns= No significant difference * = Significant difference (P≤0.05) **= Highly significant difference (P≤0.01)

The result of the analysis of variance on the mean effects of the two seasons on survival rate, number of fruit/plant and number of seeds/fruit is presented in (Table 2). The result indicated highly significant improvement in almost all the selected traits during rainy season, except on survival rates and number of seeds where significant was observed rainy in both rainy and dry seasons. This was due to effect of seasons on the selected trait in the three tomato varieties.

Table 2: Mean Separation Between Rainy and Dry Seasons on Selected Traits in Tomato.

Seasons	Survival rate (%)	Number of fruit	Number of seeds/fruit
DRY	50.40a	3.87a	51.07b
RAINY	46.37b	3.85a	62.31a

Means within the columns with the same letter(s) are not significantly different.

The result of the mean effects of different concentrations of sodium azide on the selected traits of tomato prescribed in (Table 3). The result showed that, 77.61% of the mutants treated with 0.1mM concentration germinated after one week of planting; and the germination rate decreases to 44.50% among those treated with 2.0 mM. Similarly, 80.27% of the mutants treated with 0.1mM germinated after two weeks of planting while 57% of those treated with 2.0mM germinated after two weeks of planting. More so, 67.59% of the mutants treated with 1.0mM concentration survived to maturity stage. Furthermore, the mutants treated with 0.1mM concentration, produced large number of fruits (6 fruits /plant). More so, the number of seeds produced by the mutants treated with 0.1mM (0.43 mm and 66 seeds/fruit) are higher than that of all other mutants. This was due to effect of Sodium Azide concentrations on the selected trait in the three tomato varieties.

Table 3: Mean separation of (NaN_3) Concentration on Some Growth Parameters on Three Varieties of Tomato.

Conc. (mM)	Survival rate (%)	Number of fruit	Number of seeds/fruit
0.0	29.65^{d}	2.03	45.01^{d}
0.1	67.59^{a}	6.35^{a}	66.74^{a}
1.0	54.16^{b}	4.12^{b}	60.29^{b}
2.0	42.13^{c}	2.92^{c}	52.64^{c}

Means within the columns with the same letter(s) are not significantly different.

The result of the on the effects of mutation and seasons interaction on survival rate, number of fruit/plant and number of seeds/fruits was shown in (Table 4)below. However, a combination of mutation and season is more efficient during the dry season in terms of almost all the selected traits i.e.(survival rate, fruit number and number of seeds/fruits), but was found to be efficient on survival rate and number of fruit, except on number of seeds/fruits where it was found to be more efficient in rainy season.

Table: 4. Mean Separation of Sodium Azide Concentration and Seasons Interactions on Growth of Some Growth Parameters on Three Varieties of Tomato.

Seasons	S.A. Conc. (mM)	Survival rate (%)	Number of fruit	Number of seeds/fruit
DRY SEASON	**0.0**	31.23^{d}	1.96^{d}	42.03^{d}
	0.1	68.82^{a}	6.22^{a}	59.81^{a}
	1.0	57.24^{b}	4.22^{b}	54.00^{b}
	2.0	18.78^{c}	3.03^{c}	48.29^{d}
RAINY SEASON	**0.0**	28.07^{d}	2.11^{d}	48.00^{d}
	0.1	62.37^{a}	6.48^{a}	77.66^{b}
	1.0	51.08^{b}	4.00^{b}	66.59^{b}
2.0		24.65^{c}	2.81^{d}	51.60^{c}

Means within the columns with the same letter(s) are not significantly different ($p \leq 0.05$

DISCUSSION

The distinct differences were observed in most of the quantitative and qualitative traits among the sodium azide induced mutants of tomato, this revealed significant improvements in the selected traits. Although there were few traits with no significant differences in responses to the applied treatments; the ability of the mutants to germinate faster after one and two weeks of planting in respect to the controls showed that the mutagenic treatments revealed increase enzymatic activities, which could be responsible for the early germination. This corroborate the findings of (Mensah *et al.* (2005) who reported decreased in germination with increase in the dose of chemical mutagens. In the present investigation, germination, survival percentage, plant heights and leaf number and area decreased with increasing concentration of sodium azide. This agreed with the earlier report by Ahloowaliaand Maluszynski (2001) that, the viable mutants observed are mainly dependable measure of genetic effect in mutagen. The increased in the number of leaves, plant heights and number of fruits per plant due to the applicationof sodium Azide is also in conformity with the work of Adamu and Aliyu (2007) who reported increased in growth and yield parameters of tomato due to sodium azide treatments. There were reductions in the germination and survival percentages with increasing concentrations for both chemicals in the C_1 generation. Reductions in germination and survival percentages due to the effects of mutagens on various crop plants have earlier been documented by Mensah and Akarnah *et: al*., 2004) and Mensah *et: al*., (2005).

The improvement in the growth and yield components of tomato due to sodium azide treatments expressed the effect of mutation on the growth and yield of plants. This is in conformity to the work of Adamu *et: al,*. (2002) when groundnut was treated with gamma rays and Sheeba *et: al*.. (2005) when gamma rays and EMS were used to treat *Sesanum indicum* L. where seed germination, seedling survival, were reduced significantly with an increase in dosage levels of both mutagens. However, in contrast, Sasi *e:t al,*. (2005) showed that all plant mutant types registered lower yields compared to their parents in the study of the effects of Seasons and EMS on Okra (*Abelmoschus esculentum* (L.) var. MDU-1).

The increased in fruit quality (such as thickness, juice and fruit weight) and number due to induced mutagenesis by sodium azide signifies the vital role played by the mutagen in improving the quality traits of tomato.

CONCLUSION

The effect of Sodium Azide and season interactions was found to be beneficial in improving certain qualitative traits of tomato varieties. Variety UC is therefore recommended for processing industries. More so, Induced mutation using various concentrations of sodium azide technique were employed singly and in combination on the three varieties of tomato with the aim of improving the growth and yield parameters of the plants in both the wet and dry seasons.

It was concluded that, sodium Azide via mutation improves some important quality traits of tomato that are of high economic value and possible recommendations made.

RECOMMENDATIONS

This research recommends the following:

i. Lower concentrations of sodium azide in the form of 0.1mM should be used for inducing favorable mutations in tomato.
ii. Further cytological and molecular researches should be taken on the improved tomato cultivars to further clarify the genetic bases of these beneficial methods of improvement.
iii. Further researches should be embark upon the mutants to test for disease and stress tolerance.

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