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RESEARCH ARTICLE

Effect of chemical mutagenesis on storage root formation in sweetpotato (*Ipomoea batatas* (L.) Lam)

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Abstract

Field experiments were conducted with the aim of establishing the influence of chemical induced mutagenesis on percentage storage root formation of four varieties of sweetpotato in the M_1V_1 and M_2V_2 generations. Vine cuttings obtained were soaked in Sodium Azide (SA) and Colchicine (COL) mutagens at various concentrations: 0%, 0.03%, 0.05% and 0.07%, for 2 hours. The experiment was laid out using a split-plot arrangement fitted into a Randomized Complete Block Design and replicated three times. For the sodium azide treatments, percentage storage root formation reduced as the mutagen concentration increased; while for the colchicine treatments, COL 0.00% tubered more than the other concentrations in the M_1V_1 generation. In the M_2V_2 generation though no significant difference was observed between SA 0.00%, SA 0.03%, and SA 0.05% among the sodium azide treatments; there was a decrease in percentage storage root formation among the colchicine treatments as the concentration increased. The result in this research suggested that the formation of storage roots in varieties of sweetpotato used in the study was affected to different extents by chemical mutagens. It may therefore be necessary to compare the effects of different mutagens on yield parameters of different varieties of sweetpotato to arrive at a dosage that can exert a maximum variability for selection of useful traits.

Key words: Colchicine, mutagenesis, sodium azide, sweetpotato, root formation

Introduction

Sweetpotato is the only species that produces tuberous roots out of the about 500 other species of the genus *Ipomoea* (Afuape *et al*., 2014) and is cultivated mainly for the storage roots, which are usually eaten fresh, boiled, fried or roasted (Nwankwo *et al*., 2021). Its storage roots, leaves and tender vines all have economic and dietary values (Antiaobong and Bassey, 2009). It's also called as poor man's food in the African countries. Mutagens are used in the crop improvement to create variability where its difficult to produce by natural crossing or selection. Sodium Azide and Colchicine have been proved their worth as mutagens in generating genetic variability in the tuber crops along with *Ipomoea* (Rajib and Jagatpati, 2011).

Sodium azide (NAN_3) has been one of the most powerful mutagens in crop plants (Fahad and Salim, 2009) and is perhaps the least hazardous and the most efficient mutagen as its yields of mutations are achievable at moderate sterility rates (Asad *et al*., 2014). Colchicine, on the other hand, is a chromosome doubling agent (Rajib and Jagatpati, 2011) and also a mutagenic agent (Bragal, 1955).

Self-and-cross-incompatibility restricts the use of genetic resources in clonally propagated crops such as sweetpotato. And as such, it is very hard to breed new varieties and improve varieties through cross breeding (Martin, 1965) in such crops. Also, conventional methods are limited in the improvement of sweetpotato as they are able to induce many mutations at once since sweetpotato is a polyploid and has many chromosomes (Ji-Min *et al*., 2011). To tackle this limitation, induced mutagenesis has proven a potent tool in the improvement of sweetpotato varieties (Ji-Min *et al*., 2011). Chemical mutagens have been used for an extended period of time as plant mutagens in breeding research and genetic studies (Guenet, 2004). They are efficiently used as an alternative to induce variability in different quantitative (Peddi and Dhaduk, 2014) and qualitative characters. The aim of this study however, was to establish the influence of sodium azide (SA) and colchicine (COL) induced mutagenesis on percentage storage root formation of four varieties of sweetpotato (Butter milk, TIS87/0087, UMUSPO/3 and UMUSPO/1) in the M_1V_1 and M_2V_2 generations.

Materials and methods

Field experiment was conducted at the National Root Crops Research Institute (NRCRI) Experimental Farm, Umudike, Southeastern Nigeria in 2015 (M_1V_1) and at the Eastern Farm, Michael Okpara University of Agriculture, Umudike (MOUAU) in 2016 (M_2V_2). Uniform vine cuttings (30cm long) each of four (4) cultivars of sweetpotato: UMUSPO/1, UMUSPO/3, Butter Milk, and TIS87/0087 popularly grown in the Southeastern part of Nigeria, were obtained from the National Root Crops Research Institute (NRCRI) Umudike. Vine cuttings selected at random for each treatment from the best performed M_1V_1 generation plants were used to establish the M_2V_2 generation including the control. M_1V_1 and M_2V_2 were the first and second mutative vegetation respectively. The vine cuttings were soaked in distilled water for 8 hours. The water was decanted and vines dried in a shade for 6 hours. Fresh solutions of sodium azide and colchicine were prepared in four different concentrations: 0 %, 0.03 %, 0.05 % and 0.07 %. These cuttings were now soaked in these concentrations for 2 hours at room temperature and periodically agitated. Finally, they were rinsed with running tap water for 1 hour to wash out the chemical residues before taking them to the field. The vine cuttings with 0% treatments were used as control. The experiment was laid out using a split-plot arrangement fitted into a Randomized Complete Block Design and replicated three times. The sweetpotato variety was the main plot and the sub-plot was the chemical treatments. The spacing between and within the rows were 1.0 m and 0.3 m respectively. In M_1V_1 population, each plot contained 30 plants. A total of 5040 vine cuttings harvested from M_1V_1 generation were used to establish M_2V_2 population. The site of the experiment was cleared, ploughed, harrowed and ridged. Fertilizer (NPK 15:15:15) was applied at the rate of 400kg/ha at 4 WAP by ring placement method preceding manual weeding and roguing (Ehisianya *et al*., 2012). The storage roots were harvested at 16 WAP (Ezulike *et al*., 2001).

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Percentage storage root formation was obtained by counting the number of plants that tubered expressed in percentage of the stand count at harvest. All data collected were subjected to statistical analyses using the Genstat Discovery 3rd Edition (Genstat, 2007). Separation of treatment means was done using Fisher's Least significant Difference (LSD) as described by Obi (1986). Independent analysis was done for data collected in M_1V_1 generation and for that collected in M_2V_2 population.

Results and discussion

Induced mutagenesis remains an established method for plant improvement whereby plant genes are altered by treating seeds or other plant parts with chemical or physical mutagens (Datta, 2009). Since variability is a pre-requisite for any breeding programme to evolve high yielding varieties with other desirable attributes, induced mutations can be used to induce favourable variation in characters (Mohammad and Seyed, 2014).

The purpose of this study was to establish the influence of SA and COL induced mutagenesis on percentage storage root formation of sweetpotato in the M_1V_1 and M_2V_2 generations. In the table1 showed the effect of SA and COL mutagens on percentage storage root formation of four varieties of sweetpotato in the M_1V_1 generation. SA and COL 0.07% attained 100% lethality in TIS87/0087 and UMUSPO/3 as those that sprouted did not survive till the 4th week. For the SA treatments, percentage storage root formation reduced as the mutagen concentration increased; while for the COL treatments, COL 0.00% tubered more than the other concentrations as shown by the mean values recorded. Asare and Akama (2014) reported a reduction in storage root formation only at the highest concentration of mutagens in sweetpotato. They however concluded that even though the variety induced had low performance for storage root formation in the first generation, the next generation might perform better because of the genetic variability that has been created through mutation induction (Asare and Akama, 2014). The successful use of sodium azide and colchicine mutagens to produce genetic variation in plant breeding have been reported in many crops (Ashish *et al.*, 2011; Castro *et al.*, 2003; Jain, 2010; Jaya and Selva, 2003).

Table 1: Effect of sodium azide (SA) and colchicine (COL) mutagens on percentage storage root formation of sweetpotato in the M_1V_1 generation

Mutagen Concentration (%)	Variety				
	Butter Milk	TIS87/0087	UMUSPO/3	UMUSPO/1	Mean
SA 0.00	97.10	100.00	100.00	100.00	99.27
SA 0.03	53.33	94.58	100.00	80.25	82.04
SA 0.05	44.44	94.44	40.91	54.04	58.46
SA 0.07	33.33	0.00	0.00	44.44	19.44
Mean	57.05	72.26	60.23	69.68	64.80
COL 0.00	100.00	100.00	100.00	100.00	100.00
COL 0.03	100.00	91.11	91.67	98.33	95.28
COL 0.05	100.00	100.00	96.97	100.00	99.24
COL 0.07	100.00	0.00	0.00	100.00	50.00
Mean	100.00	72.78	72.16	99.58	86.13
Grand mean	78.53	72.52	66.19	84.63	75.47

In the M_2V_2 generation, result in Table (2) showed that while there was no significant difference between SA 0.00% (100.00%), SA 0.03% (99.70%) and SA 0.05% (99.26%) among the SA treatments; there was a decrease in percentage storage root formation among the COL treatments as the concentration increased. This is contrary to the conclusion of Asare and Akama (2014). In this research we demonstrated that sodium azide and colchicine chemical mutagens had more negative influence on percentage storage root formation in the M_1V_1 than in the M_2V_2 generation. The higher concentrations of mutagens have been reported to cause disturbance in genetical and physiological activities (Fahad and Salim, 2009). Sato and Gaul (1967) attributed such decrease to cytogenetic damage and physiological disturbances. The result in this investigation suggested that different varieties of sweetpotato used in the study responded differently to different mutagenic treatments at specific concentrations for percentage storage root formation. It may therefore be pertinent to compare the effects of different mutagens on growth and yield parameters of different varieties of a crop to arrive at a valid conclusion for that particular crop.

Table 2: Effect of sodium azide (SA) and colchicine (COL) mutagens on percentage storage root formation of sweetpotato in the M_2V_2 generation

Mutagen Concentration (%)	Variety				
	Butter Milk	**TIS87/0087**	**UMUSPO/3**	**UMUSPO/1**	**Mean**
SA 0.00	100.00	100.00	100.00	100.00	100.00
SA 0.03	100.00	98.81	100.00	100.00	99.70
SA 0.05	98.89	98.16	100.00	100.00	99.26
SA 0.07	98.85	0.00	0.00	100.00	49.71
Mean	99.44	74.24	75.00	100.00	87.17
COL 0.00	100.00	100.00	100.00	100.00	100.00
COL 0.03	100.00	95.08	98.18	100.00	98.32
COL 0.05	93.23	82.24	83.33	100.00	89.70
COL 0.07	83.03	0.00	0.00	91.50	43.63
Mean	94.07	69.33	70.38	97.88	82.91
Grand mean	96.75	71.79	72.69	98.94	85.04

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