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Effect of Alpha-spin Nanoparticles Bombardment on Acha (*Digitaria exilis* Kippis Staph) Accessions

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ABSTRACT

A study was conducted during the rainy season of 2017 to evaluate the morphological performance of different accessions of Acha (*Digitaria exilis*, Kippis staph) exposed to Alpha-spin nanoparticles in Lafia, Nasarawa State, Nigeria in order to determine growth and yield parameters suitable for breeding of Acha. Eight different varieties of Acha which are Loma, Jakashak, Ndai, Agyong, Nding, Napiya, Tishi and Namuruk were exposed to the Alpha-spin Nanoparticles for four different time period which were 20, 30, 50 and 60 min, respectively and the treatments with the control were laid out in a Randomized Complete Block Design (RCBD) with three replications. The results showed that Loma performed better in parameters such as weight of shaft and grain, grain weight and tiller number while Jakashak performed better in plant height, number of nodes and length of nodes. In terms of Culm size, Napiya performed better while Egyong performed better in Leaf area and Nding recorded the earliest full germination. The varieties responded better under the 60 min exposure for parameters such as grain weight, straw weight, culm size, length of node and Tiller number. Plant height and Leaf area was highest under 30 min, Number of nodes was highest in the control while earliest germination was recorded under the 20 min exposure amongst the varieties. The results generally showed that Loma, Jakashak and Namuruk were the best performing varieties while exposure to 60 min period of time is better if treating Acha for improved performance.

Key words: Growth, yield, treatment, performance, germination

INTRODUCTION

Acha (*Digitaria exilis*) is a cereal crop which belongs to the family Poaceae and also referred to as "a small seed with a big promise" about three hundred species which are sometimes grown as fodder[1]. It is an important diverse crop species mostly grown in the savannas of West Africa and produces grains that have potential to improve nutrition, boost food security, foster rural development and support sustainable use of the land[2]. The crop is a traditional cereal well adapted to local conditions and has good nutritional and culinary properties[3]. Acha is used in some areas for managing diabetes, making the grains very relevant in addressing some challenges in today's food formulation both from functionality and health perspectives.

In Nigeria, Acha is majorly cultivated in Plateau, Bauchi, Kebbi, Kaduna, Niger and Nasarawa States and recently among the local farmers in the Federal Capital Territory area[4]. An increase in the consumption of Acha in Nigeria has been reported and that the

percentage in food demand increases with increase in yield over the years[5]. However, Acha production in Nigeria is faced with a number of problems, one of which is low yield[6], which is largely due to the small grain size that shatters and matures unevenly, resulting in the crop not being fully exploited and has generally remained unimproved. The small grain size have also constitute a problem with harvesting thereby making mechanical harvesting almost impracticable due to its logging, which is a wild character[7]. Currently, the genetic improvement of the crop centers on germplasm collection and morpho-agronomic characterization with the objective of broadening the crop gene pool[8]. However, morphological characterization alone might not provide the much needed diversity for breeding program. Also, the traditional hybridization for new cultivar appears unfeasible due to the miniature size of the floral organs and inadequate floral biology[8].

The current challenges of sustainability, food security and climate change are engaging researchers in exploring the field of nanotechnology as new source of key improvements for the agricultural sector. Several technological innovations have been employed in agricultural improvement of plants which have resulted in, hybrid varieties, synthetic chemicals etc, therefore, it will be of immense importance for researchers to seek in nanotechnology a new source of agricultural improvements[9].

Alpha-Spin optimizes the natural frequency as it can increase harmony in a body by stimulating vital life energy. Any contact with Alpha-Spin, the molecular structure is will create smaller clusters that will make penetration and absorption easy by fully optimizing the body's molecular and cellular functions via resonance and then forming a vortex that results in the expression of a quantum energy field which will exert it's effect in the content of an organism body. Its functions include the improvement of absorptions and increase hydrations, improve micro circulation. It can also be used to facilitate the flow of energy through reflexology frequency, through which it can improve plant growth and seed germination and extend the shelf life of fruits and vegetables[10]. The aim of this work was to create variability in selected Acha accessions for improved yield and selection of the best adaptable accessions for further breeding work on the crop by evaluating the morphological characteristics of Acha treated with various levels of Alpha spin nanoparticles in the field.

MATERIALS AND METHOD

Study area: The study was conducted during the rainy season from June- November, 2017 at the Botanical Garden of Federal University Lafia, Nasarawa State, located on 8°32'N 8°18'E in the Southern Guinea Savannah Region of North-Central Nigeria, with annual rainfall ranging between 1000-1400 mm, temperatures of between 25-35°C and relative humidity average of 69.8%.

Experimental design: The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications Eight different Acha varieties or accessions were exposed to four levels of Alpha Spin nanoparticles at 20 min (N1), 30 min (N2), 50 min (N3) and 60 min (N4) before planting. Plots measuring 2 m by 3 m with inter and intra row spacing of 1 m each were used giving a total plot size of 1349 m^2. These treatments along with a control were done in a randomized complete block design (RCBD) with three replications.

Planting rate: The standard planting rate of 40 kg of seeds per hectare was adopted, which gives a planting rate of 24 g of seeds per plot measuring 6 m^2.

Harvesting: Harvesting was done manually for two days at 17th week after planting, after the rains had stopped.

Number of days to 50% germination: The number of days to germination of about half of the seeds planted was observed and recorded.

Number of days to full germination: The number of days to the full emergence/germination of the seeds was observed and recorded.

Tiller number: Three plants were randomly selected in each plot and their Tiller number counted and recorded. The means for each was computed.

Number of nodes: The Nodes of each of three plants selected was counted and recorded and the means computed.

Length of node: The Longest Nodes of each of three plants selected was measured using a meter rule recorded and the means computed.

Plant height: The length of each of three plants selected was measured from the base of the stem to the apex of the plant using meter rule and recorded and the means computed.

Culm size: The culm size of each of three plants selected was determined by measuring the stem at the middle using Vernier Caliper. The values were recorded and the means computed.

Leaf area: This was determined using the length and width method. The unit leaf area was estimated by the method of Montgomery[11] and reported by Chandah and Singh[12], using the equation:

$$\text{Leaf Area (LA)} = \text{Max. length (L)} \times \text{Max. width (W)} \times A$$

Where:

LA = Leaf area
L = Length of leaf
W = Maximum width of leaf
A = Constant (0.75)

Straw weight: The harvested straw for each plot was measured using a weighing balance and recorded.

Weight of grains: The grains for each plot were separated from the shaft and measured using a weighing balance and recorded.

Data analysis: The data obtained from the field were analyzed using The GENSTAT Statistical package. Treatment means were separated by means of Two Way Analysis of Variance (ANOVA) at $p<0.05$ and LSD.

RESULTS

Number of days to 50% germination: The results for Number of days to 50% germination indicates that, variety Nding showed the earliest followed by Tishi while Loma showed the late 50% germination days after planting. In terms of the treatments, the 50 min (N3) showed the earliest average 50% germination, while 20 min (N1) and 60 min (N4) exposures recorded the late average 50% germination as indicated in Table 1.

Number of days to full germination: The results for Number of days to full germination indicates that, variety Nding showed the earliest followed by Namuruk while Jakashak showed the late germination days after. In terms of the treatments, the 20 min (N1) showed the earliest average germination, while 30 min exposure (N2) recorded the late average germination as shown in Table 2.

Table 1: Mean number of days to 50% germination of Acha exposed to AlphaSpin nanoparticles

	Treatments					
Accessions	Control	N1	N2	N3	N4	LSD
EGYONG	5.667	6.00	6.33	5.33	6.33	0.2417
JAKASHAK	5.667	5.67	5.00	5.33	5.00	
LOMA	6.000	5.00	6.33	5.67	6.33	
NAMURUK	5.000	6.33	5.00	5.33	5.67	
NAPIYA	5.333	5.33	5.67	5.67	5.33	
NDAI	5.667	5.00	5.67	5.33	6.33	
NDING	5.000	6.33	4.00	4.00	5.00	
TISHI	5.670	5.00	5.00	5.33	5.00	
LSD	0.3058					

Any difference between two means in column that is more than LSD value is significant, Any difference between two means in row that is more than LSD value is significant

Table 2: Mean number of days to full germination of Acha exposed to AlphaSpin nanoparticles

	Treatments					
Accessions	Control	N1	N2	N3	N4	LSD
EGYONG	12.00	12.00	12.33	12.00	12.00	0.2124
JAKASHAK	12.00	13.00	12.00	12.00	12.00	
LOMA	11.33	11.67	12.00	12.00	12.00	
NAMURUK	11.00	11.33	11.33	11.00	11.00	
NAPIYA	12.00	11.67	12.00	12.00	12.00	
NDAI	12.00	11.67	12.00	11.37	12.00	
NDING	10.33	10.67	10.33	10.33	10.67	
TISHI	11.67	11.00	11.33	11.00	11.33	
LSD	0.2686					

Any difference between two means in column that is more than LSD value is significant, Any difference between two means in row that is more than LSD value is significant

Table 3: Mean plant height (cm) of Acha ascensions exposed to AlphaSpin Nanoparticles

	Treatments					
Accessions	Control	N1	N2	N3	N4	LSD
EGYONG	56.33	47.00	50.00	48.00	44.67	4.293
JAKASHAK	53.67	48.67	63.33	57.67	57.33	
LOMA	57.67	45.00	48.00	44.33	50.33	
NAMURUK	52.33	63.00	49.67	48.33	49.67	
NAPIYA	47.33	43.33	56.67	53.33	57.67	
NDAI	49.67	42.67	54.00	54.33	47.00	
NDING	52.33	47.67	49.00	44.33	45.67	
TISHI	54.33	48.00	47.00	52.67	49.00	
LSD	5.430					

Any difference between two means in column that is more than LSD value is significant, Any difference between two means in row that is more than LSD value is significant

Mean plant height (cm): The results for Plant height indicates that, variety Jakashak had the highest plant height followed by Loma while Nding had the least Plant height. In terms of the treatments, the 30 min (N2) showed the highest plant height followed by the control while 20 min exposure (N1) recorded the least plant height as shown in Table 3.

Table 4: Mean culm size (cm) of Acha exposed to AlphaSpin nanoparticles

	Treatments					
Accessions	Control	N1	N2	N3	N4	LSD
EGYONG	1.013	1.210	1.210	1.150	1.117	0.0813
JAKASHAK	1.397	1.137	1.227	1.200	1.317	
LOMA	1.160	1.210	1.310	1.167	1.233	
NAMURUK	1.137	1.047	1.207	1.200	1.120	
NAPIYA	1.227	1.167	1.317	1.313	1.233	
NDAI	1.187	0.980	1.083	1.380	1.397	
NDING	1.190	1.233	1.137	1.083	1.083	
TISHI	1.013	1.160	1.290	1.210	1.227	
LSD	0.1028					

Any difference between two means in column that is more than LSD value is significant, Any difference between two means in row that is more than LSD value is significant

Table 5: Mean number of nodes of Acha exposed to AlphaSpin nanoparticles

	Treatments					
Accessions	Control	N1	N2	N3	N4	LSD
EGYONG	11.00	10.00	10.33	10.33	11.00	0.757
JAKASHAK	12.67	11.33	12.33	12.00	10.67	
LOMA	11.33	9.33	9.67	10.00	10.33	
NAMURUK	11.33	11.00	13.00	11.33	10.67	
NAPIYA	10.33	9.33	10.67	12.00	12.00	
NDAI	11.67	10.67	10.67	11.67	9.67	
NDING	11.33	9.67	11.33	9.67	10.00	
TISHI	11.33	9.67	9.67	9.67	10.33	
LSD	0.958					

Any difference between two means in column that is more than LSD value is significant, Any difference between two means in row that is more than LSD value is significant

Mean culm size (cm): The results for Culm size indicates that, variety Napiya had the highest average size followed by Jakashak and Loma while Egyong was the least. In terms of the treatments, the varieties performed better under 60 min exposure (N4), followed by 40 min exposure (N2) while 20 min recorded the least performance as shown in Table 4.

Mean number of nodes: The results for Number of Nodes indicate that, variety Jakashak had the highest Number of Nodes followed by Namuruk while Tishi had the least Number of Nodes. In terms of the treatments, the control had the highest number of Nodes followed by the 60 min exposure (N4), while 20 min exposure (N1) recorded the least Number of Nodes as shown in Table 5.

Mean length of node (cm): The results for Length of Node indicates that, variety Jakashak showed the highest Node length followed by Namuruk while Egyong had the least Node length. In terms of the treatments, the varieties performed better under 60 min exposure (N4), followed by 20 min exposure (N1) while the 30 min exposure (N2) recorded the least performance as shown in Table 6.

Table 6: Mean length of node (cm) of Acha ascensions exposed to AlphaSpin nanoparticles

	Treatments					
Accessions	Control	N1	N2	N3	N4	LSD
EGYONG	5.033	4.600	4.567	4.300	4.433	0.4837
JAKASHAK	5.200	5.167	4.900	5.733	5.067	
LOMA	4.900	4.133	5.200	5.033	5.733	
NAMURUK	5.300	5.000	5.333	4.833	5.067	
NAPIYA	4.767	5.233	5.067	5.000	5.033	
NDAI	4.433	4.533	4.533	5.267	4.800	
NDING	5.400	4.933	4.767	4.200	5.267	
TISHI	4.833	5.300	4.833	4.400	4.967	
LSD	0.6118					

Any difference between two means in column that is more than LSD value is significant, Any difference between two means in row that is more than LSD value is significant

Table 7: Mean leaf area (cm^2) of Acha ascensions exposed to AlphaSpin nanoparticles

	Treatments					
Accessions	Control	N1	N2	N3	N4	LSD
EGYONG	9.85	11.64	9.82	11.35	10.30	1.547
JAKASHAK	9.55	7.80	7.71	8.91	6.34	
LOMA	7.95	7.84	9.40	9.37	10.57	
NAMURUK	8.73	7.89	9.79	9.60	8.52	
NAPIYA	9.01	9.91	7.43	11.89	7.75	
NDAI	11.41	9.03	9.97	8.06	9.17	
NDING	8.91	8.91	8.70	8.98	7.79	
TISHI	8.75	6.42	7.71	9.69	9.09	
LSD	1.957					

Any difference between two means in column that is more than LSD value is significant, Any difference between two means in row that is more than LSD value is significant

Mean leaf area (cm^2): The results for Leaf area indicates that, variety Egyong showed the highest leaf area followed by Ndai while Jakashak showed the least Leaf area. In terms of the treatments, the varieties had higher leaf area under 50 min exposure (N3), followed by Control while 20 min (N1) recorded the least leaf area as shown in Table 7.

Mean tiller number: The results for Tiller Number indicate that, variety Loma had the highest Tiller Number followed by Namuruk while Ndai had the least Tiller Number. In terms of the treatments, the 60 min exposure (N4) showed the highest followed by the control, while 20 min exposure (N1) recorded the least Tiller Number as shown in Table 8.

Mean straw weight (g): The results for Straw weight after harvest indicates that, variety Loma had the highest weight followed by Namuruk and Nding while Egyong was the least. In terms of the treatments, the varieties performed better under 60 min exposure (N4), followed by 50 min exposure (N3) while the control recorded the least performance as shown in Table 9.

Table 8: Mean tiller number of Acha ascensions exposed to AlphaSpin nanoparticles

	Treatments					
Accessions	Control	N1	N2	N3	N4	LSD
EGYONG	10.67	13.08	12.00	11.83	12.17	0.813
JAKASHAK	11.67	13.25	12.42	11.83	13.83	
LOMA	16.00	10.75	12.08	11.00	14.75	
NAMURUK	12.83	11.58	13.17	12.92	14.83	
NAPIYA	12.25	11.92	13.83	12.42	12.08	
NDAI	12.92	10.42	11.83	12.33	10.83	
NDING	12.92	12.00	13.33	11.33	12.33	
TISHI	10.58	10.83	12.25	12.25	15.67	
LSD	1.029					

Any difference between two means in column that is more than LSD value is significant, Any difference between two means in row that is more than LSD value is significant

Table 9: Mean straw weight (g) of Acha exposed to AlphaSpin nanoparticles

	Treatments					
Accessions	Control	N1	N2	N3	N4	LSD
EGYONG	0	524	388	358	352	114.8
JAKASHAK	572	882	681	725	864	
LOMA	982	957	971	1032	1005	
NAMURUK	816	611	495	545	1033	
NAPIYA	840	879	836	518	848	
NDAI	394	513	582	556	526	
NDING	865	891	700	607	1015	
TISHI	586	679	983	737	741	
LSD	145.2					

Any difference between two means in column that is more than LSD value is significant, Any difference between two means in row that is more than LSD value is significant

Table 10: Mean grain weight (g) of Acha ascensions exposed to AlphaSpin nanoparticles

	Treatments					
Accessions	Control	N1	N2	N3	N4	LSD
EGYONG	0.0	45.3	28.0	29.3	23.7	25.10
JAKASHAK	63.1	133.9	58.0	64.1	105.0	
LOMA	104.0	116.9	147.6	145.4	125.5	
NAMURUK	94.1	52.4	46.5	111.3	118.9	
NAPIYA	96.7	128.4	96.5	63.6	91.6	
NDAI	32.3	49.1	82.1	62.4	59.4	
NDING	106.2	120.3	88.1	78.2	104.1	
TISHI	70.7	109.5	147.1	88.8	100.2	
LSD	31.75					

Any difference between two means in column that is more than LSD value is significant, Any difference between two means in row that is more than LSD value is significant

Mean weight of grain (g): The results for weight grains after harvest indicates that, variety Loma had the highest weight followed by Tishi while Egyong had the least weight of grains. In terms of the treatments, the varieties performed better under 60 min exposure (N4), followed by 20 min exposure (N1) while the control recorded the least performance as shown in Table 10.

DISCUSSION

The results showed that Loma, Jakashak and Namuruk were the best performing varieties while exposure to 60 min period of time is better if treating Acha for improved performance. Earliest germination was recorded under the exposure of the seeds to Alpha spin nanoparticles for 20 min, which suggests that the treatment worked as a mutagenic agent on the Acha seeds, thus exposure for shorter period or lower dose enhances early germination while longer period or higher dose delays or exert negative effect on germination. This agrees with the findings of Mensah *et al.*[13] in which it was reported that, germination decreases with increase in dose of mutagens on Sensame seed. Animasaun *et al.*[8] also reported that, Acha seeds treated with 20 Gy gamma irradiation recorded earliest germination than the control and those treated with higher doses. Vegetative culm size, length of nodes and tiller number were highest under the 60 min exposure to Alphaspin nanorparticles, which implies that, 60 min or slightly higher exposure time or dose would be appropriate in producing optimal effects in respect of vegetative characters. A similar finding was reported where it was found that, vegetative characters of Acha responded well to 80 Gy dose of gamma irradiation[8]. Also, the appropriate application of dosage or concentrations of mutagens has been found to improve vegetative yields in Cowpea (*Vigna unguiculata*)[14]. The difference in response of vegetative characters to different levels of exposure to Alphaspin nanoparticles suggests that it might have exerted an effect on the DNA and genetic structure of the plant. This is supported by a similar study in another cereal crop where it was reported that, mutagenic agents induced notable vegetative characters in treated *Sorghum bicolor*[15].

Straw weight and weight of grains were highest under the 60 min exposure to Alpha spin Nanoparticles which shows that, optimal exposure results in increased yield of the crop. This is supported by a finding in which it was reported that, exposure of Acha seeds to optimal dose of gamma irradiation recorded the highest grain weight[8].

CONCLUSION

This study discovered that, effects of 60 min exposure of Acha to Alphaspin nanoparticles might have effected some changes in genetic material which promotes growth and yield of the plant, while exposure to shorter time or lower dose were not possibly enough to effect significant development and growth effects on the plants of the treated seeds. This study has established that, Alpha spin nanoparticles could be used to induce genetic variability for breeding improved crop and

genetic studies in Acha. Exposure of the seeds for 60 min which showed more positive effects on the crop, should be adopted for effective mutation breeding of the crop while, each of the character to be bred should be singly screened and appropriate exposure time or dose be applied.

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