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Comparative effects of alpha nano spin seeds on yield and yield components of cowpea (Vigna unguiculata (L) walp)

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ABSTRACT:
A green house and field experiments were carried out to study alpha nano spin exposure on the yield and yield components of 10 cowpea seed varieties treated at 0 min, 20 min, 40 min, and 60 min time exposure respectively. Nine (9) of these varieties were obtained from Institution of Agriculture Research (IAR), Zaria and one local variety from Nasarawa Agricultural Development Programmed (NADP), Lafia which served as the control. The experiments were conducted at the Botanical Garden, Federal University Lafia and Green house, College of Agriculture, Lafia. The trials were established using randomized complete block design with three replications. Analysis of variance for varieties, environments and varieties-by-environments interaction showed significant difference ($P<0.05$) for mean number of days to 50% flowering, mean number of days to 50% podding, mean pod length, mean number of seeds per pod, 100 seeds weight and mean grain yield kg/ha. Interactive effects of varieties and environments on alpha nano exposure revealed that Sampea 17 and Sampea 10 had lower number of days to flowering (33.08 and 33.83 days) respectively as compared to the control lafia (54.75 days) while sampea 11 and sampea 8 had the highest number of days (62.58 and 55.33 days) respectively. Number of days to podding were lower for sampea 10 and sampea 17 (47.7 and 49.4 days) respectively which were significant different ($P<0.05$) from that of the control variety Lafia (61.3days). Also, sampea 10 and sampea11 had more 100 seeds weight (17.44 g and 17.27g) than the control Lafia (16.03) and sampea 7 (15.44) and Sampea 5 (16.03) which recorded lower weights. The interaction between treatments and environments were also significant at ($P<0.05$) but no significant difference ($P>0.05$) for the interaction between varieties and treatments. The results demonstrate the potentials of improving cowpea grain yield and quality using alpha nano spin exposure. Samples performed differently in the different location which shows the importance of location in genotype x environment interaction effects.

Key words: cowpea, genotypes, environment, interaction, variability

Introduction
Cowpea (*Vigna unguiculata* (L.) Walp) is an important grain legume in the dry savannah of the tropics covering 12.5million hectares with annual production of about 3million tons.[1] Nigeria is one of the world's largest producer of cowpea with an average production of 2.92million tons followed by Niger with 1.10million tons.[2] Despite the dramatic increase in cowpea production in the sub-Saharan Africa, cowpea yields remain one of the lowest among all food legume crops, averaging at 450kg/ha in 2006-2008, which is half of the estimated yields in all other developing regions. Its

yields are very low due to several constraints including poor soil and use of low yield variety of seeds as planting material.[3] Cowpea (*Vigna unguiculata* (L.) Walp) is a major staple food crop in sub-Saharan Africa, especially in the dry savannah regions of West Africa. The seeds are major source of plant proteins and vitamins for man, feed for animals, and also a source of cash income.[4] The young leaves and immature pods are eaten as vegetables. There is a big market for the sale of cowpea grain and fodder in West Africa. In Nigeria, farmers who cut and store cowpea fodder for sale at the peak of the dry season have been found to increase their annual income by 25%.[5]

Nanotechnology is a new emerging and fascinating field of science that could open a large scope of novel application in the fields of biotechnology and agricultural industries because nano particles (NPS) have unique physiochemical properties, i.e. high surface area, high reactivity, terrible pore size and particle morphology. Nano particles can serve as "Magic bullets", containing herbicides, nano pesticides, fertilizers or genes which target specific cellular organelles in plant to release their content, [6]. There are new challenges in agricultural sector. Such challenges include a growing demand for healthy and safe food, an increasing risk of disease, and threats to agricultural production from changing weather patterns. Nanotechnology has the potential to revolutionize the agricultural and food industry with new tools.[7] Few studies have been conducted on the mechanisms by which nano particles exert their effect on plant growth and development. Plants and nanoparticles interacts on a daily basis and this have a lot of effects on the plants physiology and morphology depending on the chemical compositions, size, surface covering, reactivity and most importantly the dose at which the nanoparticles are administered and this also depends and varies between plants.[8] Titanium Dioxide Nanoparticles showed an increase in nitrate reeducates in Soybean (Glycine max), enhance the ability to absorb/use water, and stimulate the antioxidant system. TiO2 nanoparticles treated seeds produced plants that had 73% more dry weight, three times higher photosynthetic rates, and 45% rise in chlorophyll a formation compared to the control over the germination period of 30 days.[9] [10], also reported that T_1O_2nano particles promoted nitrogen metabolism in the plant leading to growth of the plant as a whole. Zinc oxide NPs have potential to boost the yield and growth of Peanut seeds, promote seed germination, seedling vigor, and plant growth. It has also proved to be effective in increasing stem and root growth in peanuts and has also been used as fertilizer. Nano powder has been successfully used as fertilizers and pesticides as well.[11] The yield of wheat plants grown from seeds which were treated with metal nanoparticles on average increased by 20–25%.[12] It can be helpful in the increase production of useful small edible plants such as spinach, radish, rye or grain like maize, rice, and wheat etc,[13].

Therefore, the present study highlights the key role of alpha nano spin seeds of cowpea varieties on yield and yield components. Moreover, nano science contributes new ideas leading us to understand the suitable mode of action of nano particles in plants. The appropriate elucidation of physiological, biochemical and Molecular Mechanism of nano particles in plant leads to better plant growth and development. Therefore, their understanding is important for the effective use of nanotechnology in agriculture. Plant molecular biologist are redesigning molecular tool kits to engineer plants with precision because they are armed with genomic information and nanotechnology.[14]

2. MATERIAL AND METHODS

Field and green house experiment were conducted at the Botanical garden, Federal University and in a greenhouse college of Agriculture, during the rainy season from August to November 2017 at Lafia, Nasarawa State, located on 8E32'N 8E18'E in the Southern Guinea Savannah Region of North-Central Nigeria, with annual rainfall ranging between 1000-1400 mm, temperatures of between 25-35EC and relative humidity average of 69.8%. Nine genotypes of cowpea were obtained from the Institute of Agriculture Research (IAR) Samaru, Zaria and one from Nasarawa Agricultural Development Program (NADP), Lafia.

The cowpea seed varieties were exposed to four levels of Alpha Spin nanoparticles at 0 min, 20 min, 40 min, and 60 min termed as T_0, T_1, T_2 and T_3 respectively. The varieties used were Sampea 12, Sampea 11, Sampea 10, Sampea 7, Lafia, Sampea 6, Sampea 8, Sampea 16, Sampea 17 and Sampea 5. The growth habit of these varieties vary, Sampea 12, Sampea 11, Lafia and Sampea 6 were indeterminate while Sampea 8, Sampea 16, Sampea 17 and Sampea 7 were determinate but Sampea 10 and Sampea 5 were semi-erect. Each plot size measuring 3 m x 3 m (9 m^2) was manually cleared using cutlass and hoe for the ridges. Two seeds each of the selected cowpea varieties were sown per hole with a planting depth of 2 cm, with an inter-row spacing of 75 cm and intra-row spacing of 50 cm respectively for the field experiment, while for the greenhouse experiment, varieties were planted in pots and in each pot two seeds were sown at 2 cm dept. The two trials were established using Randomized Complete Block Design with three replications. Weeding was carried out manually with hoe at two weeks and six weeks after planting on the field and hand picking in the green house. Days to 50% flowering and 50% podding were recorded and at harvest, data were collected on pod length, number of pods/plant, number of seeds/pod and 100 seeds weight.

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 AND DISCUSSIONS

The results of the effects of alpha nano exposure on the different cowpea genotypes at different locations on yield and yield components are presented in Table 1-5.The effect of alpha nano exposure on mean number of days to 50% flowering, mean number of days to 50% podding, mean number of pods/plant, mean number of seeds/pod, mean pod length and 100 seeds weight (Table 1). The combined analysis of variance shows that the treatments were significantly different ($P<0.05$) for mean number of pods/plant, mean number of seeds/pod, mean pod length and 100 seeds weight. The performance of T_3 (60 min) exposed seeds were better for number of pods/plant (24.44) , mean number of seeds/pod(8.64) , mean pod length (13.17 cm) and 100 seeds weight (15.41g), [15] reported 60 min period of time being better in treating Acha for improved performance, while T_1 (20 min) exposure reduces the number of days to flowering (42.45 days) and podding (49.4 days) by 97.6% and 95% respectively. [16], reported that flowering commenced in Rupali (Cowpea) studied between 49 DAP and 69 DAP and podding began 8-9 days after flowering.

Significant difference ($P<0.05$) also exists among varieties exposed to Alpha spins grown at the two different locations (Table 2). The combined analysis of variance shows that Sampea 12 (35.04 days) and Sampea 6 (37.13 days) flowered earlier while Sampea 10 (46.9 days) and Sampea 6 (47.7 days) podded earlier, Sampea 12 (26.33) and Sampea 10 (25.65) produced more mean number of pod/plants, Sampea 16 (9.86) and Sampea 17 (9.32) had more number of seeds/plant, pod length was recorded higher with Sampea 8 (16.29 cm) and Sampea 11 (15.01 cm), mean 100 seeds weight was formed more with Sampea 10 (16.43 g) and Sampea 8 (15.85 g). This could be due to the fast penetration and transformation in the various tissues of the exposed seeds by the alpha nano spin.

Effects of the different environment on yield and yield parameters of cowpea varieties (Table 3) showed that there was significant difference ($P<0.05$) between field trial and greenhouse trial on the studied parameters. Mean number of days to 50% flowering (41.25 days) and mean number of days to 50% podding (51.3 days) were earlier in the greenhouse trial than on the field but mean number of seeds/pod (12.55), mean pods/plant (30.72), mean pod length (13.46 cm) and 100 seed weight (16.46 g) performed better on the field than in the green house. Quantitative traits or characters are of major importance in breeding, although each of these traits expressed strong environmental effect[17]. The reproductive traits performed better in the green house while the yield traits performed better on the field. The immediate switch from vegetative growth to reproductive growth by the varieties in the green house might be due to the possible favorable environmental factors such as light quality, duration and temperature, as the plants were growing up without creeping even for those varieties with indeterminate growth or likely as a result of stimulation of the numerous genes that contribute to the endogenous regulatory pathways.

Interactive effect between alpha nano spin and environments (table 4), was significantly ($P<0.05$) different, each of the alpha nano exposure period performed better on the field than in the green house. The Performance of each of these treatments within the field and within the green house were significantly different for mean number of seeds/ pod (12.42-12.81 field & 3.42-4.47green house), mean number of pods/plant (25.66-33.06 field & 15.45-15.88 green house) and mean 100 seeds weight (16.22-16.70 field & 11.10-14.13 green house) which suggest that these treatments acts as inoculant which helps in increasing food production and quality. [18] and [19] reported that increase in number of pods/plant with Rhizobia inoculation on the field were significantly more than the values obtained from the greenhouse farm site. There was a decline in mean number of pod/plant, pod length and seed formed per pod in the greenhouse trial as compared to the field trial. Seed yield of individual cowpea plant is determined by the number of pods, seed/pod and seeds weight. [20], reported that number of pods is influenced most by environment and thus has greater influence on yield. Also, Interactive effect was significantly different at P<0.01 between varieties and environments for mean number of days to 50% flowering, mean number of days to 50% podding, mean number of pods/plant, mean number of seeds/pod and 100 seeds weight (Table 4).

Interactive effect was not significantly (P>0.05) between varieties and alpha nano inoculations for mean number of days to 50% flowering, mean number of days to 50% podding, mean number of pod/plant, mean pod length, mean number of seeds/pod, and 100 seeds weight (Table 4). This Finding is not in agreement with findings by, [21] who reported the interactive effect between nano fertilizer and red bean which were significantly different at P<0.05 for number of seeds/pod, 100 grain weight and grain yield.

Treatments, varieties and environment interacted significantly at P<0.05 for mean number of pods/plant, mean pod length, mean number of seeds/pod, and 100 seeds weight (Table 5). In each of these, all the field performance of the different varieties were better than those harvested from the green house and the difference is significant at P<0.05. The interaction indicates that the varieties performed differently in the environments which show the importance of site in genotype by environment interaction effect.

Table 1.

Effects of Alpha Nano spin on Genotypes and combined Environments on Yield and Yield parameters

Treatments	50% Flowery	50% Podding	Mean No: of Pods/Plant	Mean No: of Seeds/Pod	Mean pod Length	Mean 100 Seeds Weight
T0	43.47	52.0	24.36	7.92	13.01	13.66
T1	42.95	49.4	20.60	8.21	10.66	13.69
T2	42.45	49.4	23.40	8.45	13.11	14.70
T3	44.02	56.0	24.44	8.64	13.17	15.41
Mean LSD	**5.01**	**6.14**	**4.72**	**0.88**	**1.61**	**1.78**

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

Table 2

Effect of Genotypes Exposed to Alpha spin and combined Environments on Yield and Yield parameters

Varieties	50% flowery	50% Podding	Mean No: of Pods/Plant	Mean No: of seeds/pod	Mean pod Length	Mean 100 seeds weight
Samp 12	35.04	49.6	26.33	7.73	14.16	13.53
Samp 11	55.71	55.0	25.27	6.62	15.01	10.69
Samp 10	38.21	46.9	25.65	8.58	13.13	16.43
Samp 7	37.17	49.1	21.26	8.13	13.41	15.05
Lafia	49.71`	59.5	23.38	8.43	13.62	14.39
Samp 6	37.13	47.7	22.06	7.75	14.12	13.01
Samp 8	51.38	63.9	15.79	8.86	16.29	15.85
Samp 16	52.13	52.5	21.34	9.86	13.84	15.14
Samp 17	38.04	48.0	22.23	9.32	13.69	15.85
Samp 5	37.71	44.6	28.65	7.77	14.12	13.71
LSD	**7.92**	**9.71**	**7.47**	**1.39**	**2.04**	**2.82**

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

Table 3

Effects of environment on Alpha Nano spin and genotypes on Yield and Yield components

Sites	50% flowery	50% Podding	Mean No: of Pods/Plant	Mean No: of seeds/pod	Mean pod Length	Mean 100 seeds weight
Field	55.19	57.6	16.46	12.55	13.46	30.72
Green house	41.25	45.8	12.27	4.05	6.53	15.67
LSD	3.54	4.34	1.26	0.62	1.16	3.34

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

Table 4

Mean squares of the analysis of variance for 10 advance genotypes of cowpea.

Square of variance	Degree of freedom	Days to 50% pod flowery	Days to 50% podding	Mean no of pod/plant	Mean of seeds/pod	Mean pod length
Replication	2	475.329	1127.21	9.705	20.514	84.125
Treatment	3	81.679ns	193.843*	5.86150*	13.8421*	43.3907*
Varieties	9	15114.3**	340.294*	20.4395**	46.3495*	69.8418*
Environment	1	932.204*	13600.7**	4335.00**	6960.2**	1049.18**
Treatment* Varieties	27	276.276ns	199.120ns	3.60317ns	17.6562ns	29.5329ns
Treatment* Environment	3	95.1042*	166.344*	1.92400*	11.7913*	22.9418*
Varieties* Environment* Treatment	9	857.760**	281.383**	28.0474**	84.6321ns	95.1129**
Varieties* environment	27	210.314*	176.379*	3.80116*	21.6428*	30.4383*
Error	158	192.692	171.402	5.9673	19.4324	24.414
Total	239	280.993	248.648	24.9243	29.6713	35.053

Table 5

Interactive effects of varieties and environments on yield and yield components.

	50% flowery		50% Podding		Mean No: of Pods/Plant		Mean No: of seeds/pod		Mean pod Length		Mean 100 seeds weight	
Samples	Field	G.house	Field	G.house	Field	G.house	Field	G.house	Field	G.house	Field	G.house
Samp 12	37.00	33.08	51.0	48.2	36.88	15.77	12.58	2.87	15.77	3.43	16.39	10.67
Samp 11	62.58	48.83	68.3	20.9	33.75	16.79	12.57	0.67	16.79	3.42	17.22	4.17
Samp 10	33.83	42.58	47.7	46.2	36.31	15.00	12.08	5.08	15.0	6.32	17.44	15.42
Samp 7	38.83	35.50	54.7	43.6	27.47	15.05	12.18	4.08	15.05	5.15	15.44	14.67
Lafia	54.75	44.67	61.3	57.8	31.98	14.79	12.82	4.04	14.79	6.27	16.03	12.75
Samp 6	51.58	22.67	64.1	31.2	28.22	15.91	12.42	3.08	15.91	5.21	17.27	8.75
Samp 8	55.33	47.42	63.7	64.0	16.19	15.39	11.98	5.75	15.39	4.63	16.54	15.17
Samp 16	49.08	55.17	52.5	52.6	26.70	15.98	12.31	7.42	15.98	9.43	15.94	14.33
Samp 17	33.08	43.00	49.4	46.6	28.65	15.81	13.26	5.37	15.81	6.84	16.27	15.42
Samp 5	35.83	39.58	62.9	47.0	41.09	16.20	13.37	2.17	16.2	4.21	16.01	11.42
LSD	**7.92**		**9.71**		**7.47**		**1.39**			**2.42**	**2.52**	

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

CONCLUSION

Yield and yield components in the green house can be increased by maximizing the crop exposure to higher alpha nano spin, since desirable changes in the crop grown in the greenhouse could not be achieved as obtained on the field with T_3 (60mins) maximum time exposure which showed much improvement in most of the studied parameters as compared to T_1 (20mins) and T_2 (40mins) time exposure. The tremendous heavier seeds weight observed in some of the varieties as compared to the local variety, might largely be due to the differences in inherent yielding potential of the varieties being trigged by the alpha nano spin bringing about some changes in the genetic material that promoted growth and yield of the varieties. Seed exposure to shorter time or lower dose has shown effectiveness in reducing number of days to flowering and podding. Therefore, seeds exposure of crop for 60 min which showed more positive effects on the crop for field trial, 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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