International Scholars Journals

Advanced Journal of Microbiology Research ISSN 2241-9837 Vol. 12 (1), pp. 001-007, January, 2018. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Germinability and seedling vigour of some arable crops treated with Albit® bioregulator and superhormai® fungicide

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Accepted 02 December, 2018

This study assessed the germination and vigour of seeds of four arable crops (*Arachis hypogea, Digitaria exilis*, *Vigna unguiculata* and *Zea mays*) treated with Albit® bioregulator and also with superhormai® fungicide. Completely randomized laboratory trials showed that presoaking of seeds of *A. hypogea, D. exilis V. unguiculata* and *Z. mays* with 0.2 ml Albit® L^{-1} H_2O produced significantly higher germination percentage, radicle and plumule lengths (P 0.05) than those of the control. Randomized pot and field trials showed that seedling emergence percentage (SEP), seedling vigour index (SVI), shoot growth rate (SGR) and shoot biomass (SBM) of the crops treated with Albit® + superhormai® were significantly higher (P 0.05) than the control. The root biomass (RBM) of *D. exilis* and *V. unguiculata* did not significantly differ (P >0.05) due to the treatment effects. The effect of Albit® treatment on the quantity and quality of yield of the test crops under varied agroecological conditions in Nigeria deserves further investigation.

Key words: Albit® bioregulator, arable crops, germinability, shoot biomass, root biomass, seedling vigour, superhormai® fungicide.

INTRODUCTION

Cereals and legumes are the major sources of calories and protein for the tropical African populace. However, due to poor seedling establishment and poor growth resulting from inadequate crop nutrients and from patho-genic infection, a huge gap still remains between the potential yield of the crops and their actual yield. Infected seeds with pathogens often fail to germinate, transmit disease from seed to seedling and from seedling to growing plants, thus seed-borne diseases cause enormous losses to the crops (Fakir et al., 2002).

Prevailing economic and ecological problems have encouraged contemporary farmers to use biological control agents, organic fertilizer and plant growth regulators among others to boost their crop productivity. The efficacy of indole acetic acid, indole butyric acid, gibberellic acid and coconut water are among the common plant growth regulators (PGR) that have been investigated (Davies, 1995; Kadioglu and Atalay, 2002; Chen et al., 2003; Shittu et al., 2005; Sarihan et al., 2005; Sajid, 2009) . However, these PGRs do not contain biofungicide, biofertilizer and an anti-stress agent like Albit® (Zlotnikov, 2006). Foliar sprayings of Albit® were found to be necessary for reinforcement and prolongation of presowing seed treatment effect on grain crops, vegetables, sunflower and fodder grasses (Yakhtanigova, 2009). In Russia, high economic returns were achieved with the use of biological control agents including Albit®, agat- 25K (*Pseudomonas chlororaphis*) and planriz® for seed treatment of wheat and barley (Tenyaev and Donskova, 2008).

Nigerian farmers are used to seed treatment before sowing. Information on the usage of Albit® among African farmers is very limited. The biosubstance was first applied in Nigeria in 2008 on corn field and soyabeans in Sabo Farms Ltd. in Kaduna, North central Nigeria (Ballah, 2009). Its effects on germination and seedling

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vigour on Nigerian agroecologies have not been widely assessed. This study therefore investigated in the laboratory, screen house and on the field, the germinability and seedling invigoration efficacy of Albit® on four Nigerian arable crops.

MATERIALS AND METHODS

The experiments took place in the laboratory and experimental garden of the Department of Crop Science, University of Abuja mini campus, Gwagwalada, Abuja, Nigeria.

Collection of sample seeds

The tested seeds were that of *Arachis hypogea* Leguminosae (Groundnut - cv Samnut 10, Samaru ABU, Zaria), *Digitaria exilis* Poaceae (Acha - cv Jos local medium maturing*), Vigna unguiculata* Leguminosae (Cowpea - IT 89 RD-391, black eye, white coat) and *Zea mays* Poaceae (Hybrid maize - TZL ACRO SS-97, Alheri seeds, Nigeria. Ltd). The seeds were obtained from Federal Capital Territory Agricultural Development Project, Gwagwalada-Abuja, Nigeria. The certified healthy seeds were then kept in a separate poly bags but opened for 2 h daily for aeration to check the possibility of loss of viability before being sown.

Preliminary germination test

Initial germination test of each crop with 100 seeds per varietal sample were carried out using ISTA technique (ISTA, 1996). The selected seeds were first sterilized with 0.1% mercuric chloride solution for 1 min and rinsed thrice with distilled water. A set of ten seeds with three replicates were used per treatment. In each case, control experiment of untreated seeds was set up. Water was added to each plot as and when needed.

Application of Albit®

The Albit® used was obtained from FALPAS Ventures Ltd., Abuja, Nigeria. Albit® TPS is composed of poly-beta-hydroxybutyrate (6.2 g PHB L^{-1}) and a balanced set of micro and macro elements and terpenes acids. The liquid gel substance was thoroughly shaken for 1min and concentrations of 0.2, 0.4 and 0.6 ml Albit® L^{-1} water was obtained by dilution and used as the working solution in line with Zlotnikov (2006). To dilute, 0.25 L of distilled water was mixed with Albit® in a measuring cylinder and then the rest 0.75 L water was added. Presoaking of seeds was performed manually by adding 15 ml of solution to 1 Kg seeds for 8 h. The treated seeds were kept in the dark at temperature below +20°C, under ventilation in order to prevent Albit® from been utilized by saprophyte microflora of seeds that could result in efficiency decrease.

Application of Albit® and Superhormai® in the pot

Sterilized garden soil collected from the biological garden of University of Abuja mini campus was used as the growth medium. A total of 120, 21cm - diameter polypots were each filled with 2 Kg soil. The treatments were (i) seeds presoaked with Albit® followed by foliar application (SPAF); (ii) seeds presoaked with Albit®, dressed with superhormai® fungicide followed by foliar application (SPASF); (iii) seeds dressed with superhormai® only (SDS) and (iv) the control with neither Albit® nor superhormai® treatment. Each treatment and the control were replicated three times and completely randomized experimental design was involved. The liquid gel bio- substance was thoroughly shaken for 1 min and concentrations of 0.4 ml Albit® L^{-1} water was obtained by dilution and used as the working solution as indicated by the result of preliminary assessment and according to Yakhtanigova (2009). The same concentration of 0.4 ml Albit® L^{-1} H_2O was used for foliar spray. Presoaking of seeds with Albit® was performed manually by adding 15 ml of solution to 1 Kg seeds for 8 h and kept in the dark, at temperature below +20°C, under ventilation in order to prevent Albit® from losing its efficacy. For superhormai® (thiophanate methyl - 35%, thiram - 20% and diazinon – 15%) treatment, the fungicide powder (2.5 g) was added to 1 Kg seeds in a 200 ml jar, covered and thoroughly agitated for 1 min so that the seeds could be coated with the moistened fungicide. In line with Zlotnikov (2006), seeds presoaking with Albit® preceded superhormai® fungicide application. Spraying of Albit® was carried out with a standard 10 L knapsack sprayer (Albit ® solution - 0.2 mL L^{1} water). First foliar sprayings of the seedlings was carried out at 4 - 5 leaf stage and the second at 10 -12 leaf stage. This was done in the absence of rain in order to obtain maximal treatment efficiency.

Germination and seedling vigour in the laboratory, the pot and on the field

Ten presoaked seeds with Albit® and the untreated control from each of the crop species were sown in 9 cm diameter Petri-dishes lined with three layers of blotters, moisturized with 2.5 times the paper weight and set up in a germinator at 25°C in the laboratory. Water was added with 10 ml syringe to the experiment as soon as the blotter was dry. The emergence of a radicle of 5 mm was used as criterion for germination. Radicle and plumule lengths were measured in centimetre with a ruler five days after seeding.

For the pot experiment, three seeds of each varietal sample were sown per pot at a mean depth of 2 cm. During the growing period, plants were adequately watered and kept weed-free by regular hand weeding.

The field experiment was carried out in the research field of the department of crop science in the University of Abuja mini campus from June to August, 2009. The field is geographically located in the heartland of Nigeria and falls between Lat. 08° 25^{l} and 09° 21^{l} N of the equator and Long. 6° 45^{1} and 7° 39^{1} E of the Greenwich Meridian in the southern Guinea savanna agroecolgical zone of Nigeria. Ten arable crops were involved. There were 20 plots per each of the three replicates which involved randomized complete block design. Thirty plots were treated with Albit® and superhormai® while the other half were the untreated control plots.

Count of seedling emergence was obtained 10 days after sowing (DAS) before foliar spray and expressed as percentage of total number of seedling expected to emerge. Lambdacylohathrin insecticide was applied twice at 5 and 12 leaf stages, respectively. Shoot lengths were measured in centimetre with a ruler on the 14th and 28th day after seeding (ISTA, 1996). At 28 DAS, plants in each pot were carefully lifted with ball of earth before the soil particles were gently shaken off. Then, shoot and root lengths (cm) were taken on the 24th day after sowing. Also, dry shoot and root weights (biomass) were taken with a micro chemical balance (Explorer Ohaus, USA) in grammes and recorded accordingly.

From the data collected in the laboratory seed vigour index was also calculated according to Randahawa et al. (1985) and modified as follows:

Seedling vigour index (SVI) = GP (PL + RL)/1000

Where GP = Germination percentage (%); PL=Mean plumule length

Table 1. Effect of Albit® on germination, radicle and plumule lengths and vigour of *D. exilis, Z. mays, A. hypogea,* and *V. unguiculata* seeds.

Crop	Treatment (ml Albit® L^{-1} H2O)	Five days after sowing			
		Germination percentage	Plumule length (cm)	Radicle length (cm)	Seed vigour index
D. exilis	0.6	76.67*	0.40	0.93	0.099
	0.4	86.67	0.47	0.80	0.111
	0.2	100	0.60	1.08	0.170
	0 (Control)	83.33	0.43	0.90	0.127
	LSD 0.05	7.19	0.16	0.15 ns	0.019
	LSD 0.01	9.03	0.197	0.21 ns	0.024
Z. mays	0.6	79.00	1.83	0.33	0.153
	0.4	83.33	2.07	0.50	0.214
	0.2	96.67	2.27	0.60	0.276
	0 (Control)	90.00	1.70	0.47	0.195
	LSD 0.05	20.34ns	0.297	0.29 ns	0.019
	LSD 0.01	29.59ns	0.374	0.42 ns	0.024
A. hypogea	0.6	73.33	1.60	1.63	0.241
	0.4	83.33	1.07	1.94	0.250
	0.2	93.33	1.47	2.01	0.325
	0 (Control)	73.33	0.90	1.23	0.152
	LSD 0.05	14.38	0.61 ns	0.98 ns	0.103
	LSD 0.01	18.06	0.88 ns	1.42 ns	0.129
V. unguiculata	0.6	66.67	0.37	1.25	0.098
	0.4	83.33	0.23	1.70	0.161
	0.2	100	0.30	1.60	0.202
	0 (Control)	73.33	0.22	1.57	0.165
	LSD 0.05	13.31	0.16 ns	0.52 ns	0.019
	LSD 0.01	16.72	0.23 ns	0.76 ns	0.024

(cm) and RL=Mean radicle length (cm).

From the data collected in the pot and field experiments, shoot growth rate (SGR) was also computed in centimetre per week as follows:

$SGR = SL_2 - SL_1 / T_2 - T_1$

Where SL_1 = Shoot length at 14th day; SL_2 = Shoot length at 28th day; T_1 = 14 days after sowing; T_2 = 28 days after sowing (that is, $T_2 – T_1$ = 2 weeks).

Seedling vigour index was also computed for the pot experiment data according to Randahawa et al. (1985) and modified as follows:

Seedling vigour index (SVI) = SE (SL + RL)/1000.

Where SE = Seedling emergence percentage; SL= Mean shoot length (cm); RL = Mean root length (cm).

All the SEP were taken before Albit® foliar application. Data collected were subjected to analysis of variance (ANOVA) and differences among the treatments were determined with least significant difference (LSD) at 0.05 level of probability; using SAS 9.0 (2002) statistical package. *P* values 0.05 were considered statistically significant.

RESULTS

Laboratory experiment

The result of laboratory screening of Albit® for seed invigoration efficacy was positive for the studied crop species.

a) *D. exilis* and *Z. mays*

Table 1 shows that the germination percentage of *D. exilis* seeds treated with 0.2 ml Albit® L^{-1} H_2O was significantly higher (P 0.01) than those presoaked with 0.4 ml L^{-1} H_2O and the control without Albit® application. However, the germination percentage of those treated with 0.6 ml Albit® L^{-1} H_2O was significantly lower than that of the control (P 0.05). The plumule length and seedling vigour of *D. exilis* seeds treated with 0.2 ml Albit® L^{-1} H_2O was the only one that was significantly

higher than the control (P 0.05). This trend implied that 0.2 ml Albit® L^{-1} H_2O is the optimal rate for *D. exilis.*

Germination percentage of *Z. mays* seeds did not significantly differ due to variation in Albit® concentration. The plumule length of *Z. mays* seeds pretreated with 0.2 ml Albit® L^{-1} H_2O was significantly longer than that of the control (P 0.01). The plumule length and the seed vigour of the seeds treated with 0.4 ml Albit® L^{-1} H_2O were not significantly higher than that of the seeds pretreated with 0.2 ml Albit® L^{-1} H_2O. The seed vigour of *Z. mays* seeds treated with 0.6 ml Albit® L^{-1} H_2O had the lowest seedling vigour even less than that of the control. The radicle length in *D. exilis* and *Z. mays* were not significantly increased by the Albit® seed presoaking (P 0.05).

b) *A. hypogea* and *V. unguiculata*

As early as the 18th h, the radicle of Albit® pre-treated seeds of *A. hypogea* and *V. unguiculata* started to emerge, while it took up to 28 h in the untreated control. The seeds of the leguminous crops had thin seed coat that could allow for easy absorption of the chemical during soaking.

There was highly significant difference only between the germination percentage of *A. hypogea* (P 0 .01) treated with 0.2 ml Albit® L^{-1} H_2O and the control (Table 1). Those treated with higher concentration of the plant regulator did not significantly increase in their plumule length. The seed vigour of the *A. hypogea* presoaked with 0.2 ml Albit® L^{-1} H_2O was significantly higher than that of the control (P 0.01).

The germination percentage and seedling vigour of *V. unguiculata* seeds treated with 0.2 ml Albit® L^{-1} H_2O was significantly higher than that of the control (P 0.05). The seeds presoaked with 0.6 ml Albit® L^{-1} H_2O had the lowest germination percentage and seedling vigour even less than the control. The plumule and the radicle length of *A. hypogea* and *V. unguiculata* were not significantly affected by the Albit® application.

Pot experiment

Germination test showed that all the collected seeds had up to 80% germination. Application of Albit® seed presoaking and foliar spraying only enhanced the germination emergence and growth vigour of the tested crops, but higher efficacy was observed when the seeds were in addition, dressed with superhormai® fungicide.

a) *D. exilis* and *Z. mays*

The seedling emergence percentage (SEP) of *D. exilis* seeds presoaked with Albit® and dressed with superhormai® fungicide was significantly higher (P 0.05) than the control (Table 2). The seedling vigour index (SVI) of *D. exilis* seeds presoaked and foliar sprayed with Albit® (SPAF) or Albit® treated combined with superhormai® seed dressing (SPASF) were significantly higher (P 0.05) than that of the control. The shoot growth rate (SGR) of the crop treated with SPAF or SPASF were significantly higher (P 0.05) than that of the control. The shoot biomass (SBM) of the *D. exilis* treated with SPAF or presoaked with superhormai® only (SDS) was significantly higher (P 0.05) than that of the control. The root biomass (RBM) however did not significantly differ due to the effects of the treatment (P > 0.05).

The SEP of *Z. mays* seeds presoaked with Albit® and dressed with superhormai® were significantly higher (P 0.05) than the control. The SVI of the *Z. mays* treated with SPAF, SPASF or SDS was significantly higher (P 0.05) than that of the control. Also, the SGR and SBM of *Z. mays* treated with SPASF were significantly higher (P 0.05) than those of the SDS and the control. The RBM of *Z. mays* seeds dressed with SDS was not significantly higher (P > 0.05) than that of the control.

b) *A. hypogea* and *V. unguiculata*

The SEP and SGR of *A. hypogea* seeds presoaked with Albit® and dressed with superhormai was significantly higher than that of the control. The SVI of *A. hypogea* that received any of the treatments were significantly higher than that of the control (P 0.05). The SBM and RBM of *A. hypogea* treated with SPASF were signi-ficantly higher than the control (P 0.05). There was no significant difference between the RBM (P > 0.05) of *A. hypogea* treated with SPAF or with SDS.

The SEP of *V. unguiculata* seeds presoaked with Albit® and dressed with superhormai® was significantly higher than those treated with SPAF, SDS and the control (P 0.05). The SVI of *V. unguiculata* treated with SPASF was significantly higher (P 0.05) than those treated with SDS and the control. The SGR and SBM of *V. unguiculata* treated with SPAF or SPASF were significantly higher than that of the control (P 0.05). Also, there were significant differences in the SBM of *V. unguiculata* treated with SPAF or SDS.

Table 3 shows that due to Albit® + superhormai® treatments, the seedling emergence of all the crops at 10 DAS increased with the highest percentage observed in *A. hypogea* (7.33%) and the least in *Z. mays* (3.33%). At 24 DAS, the treated *Z. mays* however had the highest shoot length increment (3.67 cm). The root lengths of the tested crops were not obviously increased by the Albit® + superhormai® treatments. The highest root length increment (1 cm) was observed in *Z. mays* while it was

Table 2. Effect of Albit® with or without Superhormai® on seedling emergence, seedling growth rate, shoot and root biomass and vigour of *D. exilis, Z. mays, A. hypogea,* and *V. unguiculata* seeds.

Crop	Treatment	Seedling emergence (%) 10 DAS	28 DAS			
			Seedling vigour index	Shoot growth rate (cm/wk)	Shoot biomass (g)	Root biomass (g)
	SPAF	93.3	2.307	1.60	3.60	1.15
	SPASF	100	2.663	1.11	4.00	1.20
D. exilis	SDS	90.0	1.779	0.86	3.20.	1.00
	Control	80.0	1.324	0.70	1.95	0.90
	$LSD_{0.05}$	14.3	0.457	0.15	0.95	0.50ns
	SPAF	90.0	4.905	2.65	13.10	2.42
	SPASF	96.7	5.358	2.70	11.32	2.56
Z. mays	SDS	86.7	3.898	2.09	9.23	2.27
	Control	83.3	3.004	1.73	9.84	2.06
	$LSD_{0.05}$	9.41	0.298	0.43	1.27	0.17
	SPAF	83.30	3.630	1.42	7.66	0.43
	SPASF	90.00	3.180	1.41	7.77	0.67
A. hypogeal	SDS	86.70	2.490	1.22	6.18	0.51
	Control	73.30	1.937	0.88	5.60	0.37
	$LSD_{0.05}$	9.41	0.457	0.27	0.68	0.12
	SPAF	93.33	3.686	1.87	6.20	0.43
	SPASF	100.0	4.050	1.86	6.92	0.34
V. unguiculata	SDS	93.33	3.070	1.67	5.03	0.36
	Control	80.00	2.392	1.40	4.47	0.36
	$LSD_{0.05}$	9.61	0.743	0.30	0.79	0.07ns

ns = No significant difference between the treatment means in the same column for the particular crop; DAS= Days after sowing.

only by 0.5 cm in *A. hypogea*. Treated *A. hypogea* had the highest shoot growth rate of 2.08 cm per week. At 28 DAS, the *Z. mays* shoot biomass supplied with the treatment was 1.5 g higher than the control. Treated *D. exilis* had the least shoot biomass increment of 0.3 g more than the control. The effects of Albit® and superhormai® treatments on the root biomass of the four crops were not obvious. In *D. exilis,* highest increment of the root biomass (0.35 g) was observed due to treatment effect while the least was in *V. unguiculata* (0.17 g). The highest increment in seedling vigour (0.56) was observed in *V. unguiculata* and the least in *D. exilis* (0.28).

DISCUSSION

It is shown in this study that in order to obtain the desired seed germination and vigour from Albit® application, the concentration of Albit® is a major factor. The optimal range of concentration for the biochemical presoaking should be between 0.2 -

Table 3. Effect of Albit® on seedling emergence, shoot length, seedling growth rate, shoot and root biomass and vigour of *D. exilis, Z. mays, A. hypogea* and *V. unguiculata* seeds.

Crop	Treatment	Seedling emergence (%) 10 DAS	24 DAS			28 DAS		
			Shoot length (cm)	Root length (cm)	Seedling vigour index	Shoot growth rate (cm/week)	Shoot biomass (g)	Root biomass (g)
D. exilis	Albit + S/Hormai	93.67	15.00	8.00	2.15	2.83	3.43	1.12
	Control	89.90	13.67	7.17	1.87	2.53	3.13	0.82
Z. mays	Albit + S/Hormai	88.33	21.67	12.00	2.97	2.80	8.40	1.37
	Control	85.00	18.00	11.00	2.47	2.23	6.90	1.13
A. hypogea	Albit + S/Hormai	96.33	13.28	10.50	2.29	2. 98	7.21	0.80
	Control	89.00	12.17	10 00	1.97	2.67	6.91	0.67
V.unguiculata	Albit + S/Hormai	92.76	16.76	14.33	2.88	2.85	6.17	0.68
	Control	88.33	14.33	13.67	2.32	2.32	5.37	0.56

*Each value is a mean of three replicates; DAS= Days after sowing.

0.4 ml L^{-1} H_2O depending on the nature of the seed. High concentration of Albit® up to 0.6 ml Albit® L^{-1} H_2O did not bring about a proportional increase in the germination and vigour parameters measured.

The increase in seed vigours observed was in line with the report of Hampton and Tekrony (1995), Khare (1999) and Haque et al. (2007) that presowing seed treatment of cereals with Albit® provided protection against root rots and other diseases due to earlier and accelerated development of rootage. Also, germination percentage was increased by 3 - 7%, germination energy by 10-15% and stem density by 19.7 - 37% (Kudrjavcev et al., 2005). ISTA (1996) reported that seedling quality depends on the ability of the emerging seedling to produce new roots quickly; the speed with which seedlings get anchored in the ground, start assimilating and growing after germination.

In Russia, enhanced growth of crops was obtained when Albit® seed treatments were combined with fungicides such as Vitavax 200 (carboxin + thiram) or Fenoram (carboxin). Usage of Albit® decreased chemical fungicide and fertilizer consumption and eventually increased yield, quality and economic returns of crop produce (Kandyba and Lazarev, 2001; Tenyaev and Donskova, 2008).

Yakhtanigova (2009) reported that for a pronounced effect, seed treatment with Albit® should be followed with foliar sprayings. Presowing Albit® seed treatment was reported to have made up 50-60% of total Albit® effect, the rest been obtained through foliar spraying. Combination of Albit® with chemical fungicides seems to have led to synergistic effects. Use of Albit® with only half of application rate of fungicides provided the same protective effect, as full dose of fungicides in cereals, vine and potatoes. In a test in all Russia Institute of Plant Protection of Moscow State University (2004), the antidote activity of Albit® regarding to fungicides made up 24.60%. It was inferred from the study that Albit® had the ability to induce resistance to wide range of both fungus and bacterial infections.

Albit® bioregulator has proven to be a promising agrochemical input in improving seedling quality of arable crops. Presoaking of the seeds with Albit® only followed by foliar application significantly enhanced (P 0.05) the germination and growth of most of the tested crops, but better results were obtained from the seeds that were additionally dressed with superhormai® fungicide.

This indicated the superiority of integrated approach to crop management over a one way approach. Future investigation on Albit® efficacy should involve the effect of Albit® foliar application only, effect of varied duration of presoaking of Albit® on the growth and yield of several cultivars of the selected crops, under varied field conditions and disease intensity in different agroecological zones.

ACKNOWLEDGEMENTS

We are grateful to FALPAS Ventures Ltd., an official representative of Albit® Biotechnology LLC in Nigeria and Africa for their financial assistance towards screening of Albit® efficacy on some Nigerian arable crops.

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