Research Article

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Grain Protectant Effects of Selected Weeds (Senna Occidentalis and *Setaria Palmifolia*) on Cowpea (*Vigna Unguiculata* (L.) Walp) Varieties

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Abstract

The search for effective and non-hazardous method of controlling insect and fungal pests of cowpea seeds during storage is currently trending in order to achieve food security. This research was carried out in the Crop Protection Laboratory of University of Abuja in 2021. The aim was to evaluate the effectiveness of *Senna occidentalis* (SO@0.5g/1g per 3 seeds) and *Setaria palmifolia* (SP@0.5g/1g per 3 seeds) powdered leaf extracts as protectants against *Callosobrachus maculatus* and fungal pathogens of cowpea seeds during storage. An invitro experiment was set up in a CRD structure consisting of three cowpea varieties, two test plants at two different levels (0.5g and 1g) while two chemical protectants: Dress Force powder (5g) and Fluconazole tablet (50mg) per kg of seed were used as positive controls. Analysis of insect mortality within 24 hours showed that all treatments had similar insecticidal effects (F=1.05; P=0. 441) and varieties were equally susceptible to insect infestation. Dress Force pesticide had the highest mortality (77.8%) followed Sp@1g (50.0%). At 72 hours, insect mortality differed significantly among treatments (F=33.5; P<0.05). SO@1g was the most improved treatments having recorded 97.3% insect mortality after Dress Force (100.0%). Fungicidal effects of extracts showed that all treatments (chemical and plant extracts) suppressed the growth of *Aspergillus niger*, *Fusarium* and *Penicillium* in SAMPEA 19 seeds. All treatments inhibited the growth of only *A. niger* in SAMPEA-15 treated seeds; while only chemical treatments (Dress Force and Fluconazole) suppressed the growth of all fungal species in FUAMPEA-1 treated seeds. The optimal time for fungal inhibition among treatments was observed with 24 hours of exposure using *A.niger* as a reference point. Dress Force had the highest zone of inhibition (7.4mm) followed by Fluconazole (3.53mm) and SO@1g (1.37mm) while the least inhibition was observed in *S. palmifolia* (0.23mm). This study has confirmed that the two test plants had insecticidal and fungicidal properties that could be used in the preservation of cowpea seeds during storage. However, *S.occidentalis* performed better than *S. palmifolia*. It may be exploited in the manufacture of protectants subject to further improvement. This would be a cheaper and safer source of making preservatives than the use hazardous chemicals.

Keywords: Cowpea, Grain protectant, *Senna occidentalis, Setaria palmifolia*, Weeds

INTRODUCTION

Vigna unguiculata (L.) Walp commonly known as cowpea is an important leguminous crop of high nutritional value. The grain is rich in protein and therefore it is part of daily human diets in Africa while the pods help in feeding livestock (Awurum *et al.*, 2014). Nigeria is one of the largest producers of cowpea in the world due to the high economic and dietary values attached to the grains. The main challenge facing cowpea farmers is grain damage attributed to insect pests commonly called bean weevil (*Callosobrachus maculatus*) during storage (Alabi and Adewole, 2017; Obembe and Ojo, 2018). The deteriorated condition is further aggravated by fungal attack that reduces the grains to powder, thereby rendering the grain unusable. Common examples of fungal pathogens of cowpea that cause deterioration of grains during storage include *Penicillium* spp., *Aspergillus* spp., *Botrytis* and *Fusarium* (Adarkwah *et al.*, 2018). Damaged grains cause huge economic losses to the producers, vendors and consumers (Iloba *et al.*, 2016; Adarkwah *et al.*, 2018).

Farmers and grain vendors often seek effective preventive and corrective measures to protect grains from biodeterioration and maintain good quality. Chemical protectants are highly effective insecticidal and fungicidal agents but they have been criticized as toxic to human and the environment. Many synthetic chemical protectants have been linked to organ damage while some are known carcinogens and mutagens (Iloba *et al.*, 2016; Adarkwah *et al.*, 2018; Obembe and Ojo, 2018). The current campaign focuses on the search for safer, cheaper and more available sources of protecting grains during storage than the chemical method. Some plant-based products have been tested to possess biocidal properties that may help to protect stored grains against insect and moulds without constituting health risk to consumers (Awurum and Enyiukwu, 2013; Aguoru *et al.*, 2015; Enyiukwu and Maranzu, 2017; Olasan *et al.*, 2022).

One of the important criteria for testing the biocidal potentials of any plant material is that it must be readily available for use. Also, such material must not be in conflict with food supply, meaning that it must not serve as regular food consumed by human. This is to avert food scarcity when such material is to be used as protectant (Mogosanu *et al.*, 2017; Ogunnupebi *et al.*, 2020). *Senna occidentalis* (family Fabaceae) and *Setaria palmifolia* (family Poaceae) are two plants that are commonly found as weeds around the University of Abuja campus. The insecticidal and antifungal potentials of these plants have not been documented. Bioconversion of weeds and plant wastes to useful products is a new area that may help to sustain the ecosystem (Olasan *et al.*, 2022). This present research was designed to evaluate the effectiveness of *Senna occidentalis* and *Setaria palmifolia* powdered extracts against known insects and fungal pathogens attacking cowpea seeds during storage. The outcome of this study would provide useful information on the potentials of these weed plants or otherwise as plant-based seed protectants.

METHODOLOGY

Sample Collection

Improved varieties of cowpea seeds of three varieties (FUAMPEA-1, SAMPEA-15 and SAMPEA-19) were purchased from the seed store of University of Ibadan. After proper identification, *Senna occidentalis* and *Setaria palmifolia* plants were collected from the University of Abuja. They were sun dried, crushed using a mill and sieved into a fine powder. Powders were stored in a sterilized glass jar in a dry condition until required.

Insect Multiplication

Collected bean weevils were multiplied following the procedure of Banga *et al.* (2018). This was done by placing infested seeds in a glass jar, covered with muslin cloth to allow sufficient air into the container. The culture was kept undisturbed to produce enough progeny used for the experiments.

Insecticidal Effects of Extracts

Exactly 1g and 0.5g of *Senna occidentalis* (SO) and *Setaria palmifolia* (SP) powder was weighed and poured into a sterile container containing 5ml of water to make up 100% and 50% solution respectively (Olasan *et al.*, 2021). Treated seeds were arranged in a Completely Randomized Design (CRD) with two replicates. The treated seeds were air dried for 24 hours and placed in a sterile container. Three insects (*Callosobruchus maculatus*) were inoculated. Mortality was recorded for 12, 24, 48 and 72 hours. The two extracts were compared with standards: Dress force powder (5g) and Fluconazole tablet (50mg) per kg of seed (Oyekale *et al.*, 2012).

Fungicidal Effects of Extracts

Senna occidentalis and *Setaria palmifolia* powdered extracts were prepared at two levels (0.5g and 1g). They were applied on cowpea seeds on PDA media that contained fungal inoculi in petri dishes in a CRD experiment. The Petri dishes were sealed with a masking tape and kept in the incubator at 28

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± 2°C for 3 days. Observation of fungal growth was recorded against each of the treatment (Kareem *et al.*, 2018).

Zone of Inhibition of Aspergillus *niger*

Aspergillus niger isolated from cowpea seeds was sub-cultured to obtain a pure culture for the experiment. Powdered plant extracts (0.5g and 1g). The test fungus obtained from the pure culture was placed and spread on the center of Petri dishes containing PDA using a swab stick hour (Denloye, 2010). Treatments were applied using the syringes. Three drops of the treatments. Petri dishes were sealed and kept in the incubator at 28 ± 2°C for 3 days and examined daily for growth inhibition. Effect of weed plants extracts on mycelia growth of the isolated fungus was checked. Colony diameter was taken as the mean growth along on the reverse side of the plates. The zone of inhibition was measured for 24, 48 and 72 hours (Denloye, 2010).

Data Analysis

Data analysis was done using percentages, mean and standard error. Bar graphs were plotted. Inferential statistics was applied using analysis of variance at 95% confidence limit.

RESULTS AND DISCUSSION

Effect of treatments on insect mortality at 12 hours of application

Table 1 shows the mean insect mortality @12 hours of treatment exposure where So@1g resulted in 16.7% mortality in SAMPEA-15 and SAMPEA-19 treated seeds. Dress force caused between 33% and 100% insect mortality among the three varieties while it was 0% to 33.3% in untreated seeds. Percentage mortality differed as a function of treatment (F=5.58; P=0.001) but not as a function of variety (F=1.50; P=0.269). Therefore, there was no evidence of insecticidal activities of plant extracts at 12 hours of treatments although chemical treatment appeared effective. Similar observations were made in other studies (Subbalakshmi *et al.*, 2012; Aguoru *et al.*, 2016) where 12 hours seed exposure time to plant extracts yielded no effects on insect population.

Effect of treatments on insect mortality at 24-72 hours of application

Table 2 gives the mean insect mortality @ 24 hours of treatment exposure where SO@1g and SP@1g caused 83.3% and 100% insect mortality respectively in SAMPEA-19 seeds although Dress force gave 100% insect mortality observed in other cowpea varieties. Significant differences did not exist among the treatments (F=1.05; P=0. 441) and varietal factors (F=0.37; P=0.70) indicating that all

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treatments had similar insecticidal effects while the seeds are equally susceptible to insect infestation. Grand mean insect mortality among treatments showed that Dress Force (77.8%) > Sp@1g (50.0%)> SO@1g (38.9%)> SO@0.5g (33.4%)> SP @0.5g (27.8%)> NT (16.67). This shows that Dress Force was the best at 24 hours followed by SP@1g. Plant extracts performed better at 24 hours than 12 hours exposure time against insects. Table 3 gives the mean insect mortality @ 48 hours of treatment exposure where FUAMPEA 1 and SAMPEA 19 treated with SO@1g resulted in 100% insect mortality, just as observed in SAMPEA 19 seeds treated with *S. palmifolia*. Significant differences exist in insect mortality rate among treatment types because grand mean insect mortality shows that Dress Force (100.0%) > SO@1g (94.4%)>SO@0.5g/SP@1g (61.1%)> SP @0.5g (44.4%)>untreated seeds (44.4%). This shows that Dress Force was the best at 48 hours followed by SO@ 0.5g. Table 4 gives the mean insect mortality @ 72 hours of treatment exposure where 1g of *S. occidentalis* caused 100% insect mortality in FUAMPEA 1 and SAMPEA 19 seeds. It was also observed that *S. palmifolia* caused 100% mortality in SAMPEA 19 seeds. Insect mortality differed significantly among treatments (F=33.5; P<0.05) but not at varietal factor (F=3.83; P=0.00). At 72 hours, SO@1g (*S. occidentalis*) was the most improved plant treatments having recorded 97.3% insect mortality. Hence, Dress Force (100.0%)>SO@1g (94.4%)>SO@0.5g (66.7%)> SP@1g (61.1%) >SP @0.5g (50.0 %). This shows that Dress Force was the best at 72 hours followed by *S. occidentalis* at 1g and 0.5g.

The above finding was similar to other reports where higher exposure time 24-72 hours treated seeds had more insecticidal efficacy than 12 hours (Tiroesele *et al.*, 2014; Aguoru *et al.*, 2015; Uyi and Obi, 2017; Opuba *et al.*, 2018; Fouad *et al.*, 2020). This may be due to the time taken by any physical or chemical or biological agent to penetrate into living cells to kill the cell contents. This position was earlier suggested by some workers (Mohapatra *et al.*, 2014) who studied the effect of microwave aided disinfestation of *C. maculatus* on green gram quality. Olufumilayo (2015) maintained that *Momordica charantia* extracts had higher repellent activity against *C. maculatus* at both higher concentration and exposure time. The present result showed that 72 hours period was the best to destroy all insects that infest cowpea grains treated with either of the two plant extracts tested. The higher the exposure time of these extracts, the higher the insect mortality rate. The approach used in this study was in line with the current global campaign on the bio-conversion of non-food materials into useful products to solve problems (Olasan *et al.*, 2021). In this work, invasive weed plants that grow luxuriantly within a public institution were tested for their ability to act as grain protectants in storage. Results showed that *S.*

palmifolia and *S. occidentalis* extracts exhibited some levels of insecticidal activities where the latter appeared more potent than the former. Some authors attempted to account for the mechanism of plant insecticidal activities. Denloye (2010) reported that plant materials being highly fibrous in nature contain particles that occupy the spiracles of insects causing asphyxiation that leads to death. Impairment of respiratory and alimentary system of insects by plant materials was also suggested (Kedia *et al*., 2013). The presence of different bioactive compounds in different plant materials have been known to cause significant changes in the physiology and metabolism of insects leading to death (Udebuani *et al*., 2015).

Occurrence of fungal growth in cowpea varieties

The relative occurrence of fungal growth in SAMPEA-19 treated seeds at72 hours exposure time is shown in Figure 1. All treatments (chemical and plant extracts) suppressed the growth of *Aspergillus niger, Fusarium* and *Penicillium*. Also, SP@0.5g and 1g suppressed the growth of *Aspergillus flavus* and *Botrytis.* Growth occurrence was 100% in *A. flavus* in seeds treated with SO@0.5g. Growth of *Phytophtora* was seen in all plates except those treated with chemicals. The relative occurrence of fungal growth in SAMPEA 15 treated seeds at 72 hours exposure time is shown in Figure 2. All treatments (chemical and plant extracts) suppressed the growth of *Aspergillus niger* only. *Penicillum* and *A. flavus* did not grow in all plates except in plates treated with SO@1g where 100% growth was observed. *Fusarium* also recorded 100% growth in *S. occidentalis* at 0.5g. However, only *S. occidentalis* extract (0.5g and 1g) inhibited the growth of *Botrytis.* The relative occurrence of fungal growth in FUAMPEA-1 treated seeds at 72 hours exposure time is shown in Figure 3. Only chemical treatments (Dress Force and Fluconazole) suppressed the growth of all fungal species. *A. flavus* and *Botrytis* did not grow in all plates except those treated with *S. occidentalis* (SO@1g). Meanwhile, *S. palmifolia* at 0.5 and 1g inhibited the growth of *Fusarium* and *Penicillium*. The optimal time for fungal inhibition among treatments was observed with 24 hours of exposure using *A.niger* as a reference point (Figure 4). Dress Force had the highest zone of inhibition (7.4mm) followed by Fluconazole (3.53mm) and *Senna occidentalis* at 1g (1.37mm) while the least inhibition was observed in *Setaria palmifolia* (0.23mm).

Results showed that both *S. occidentalis* and *S. palmifolia* exhibited fungicidal effects against common fungal pathogens that deteriorate cowpea grains. The above findings are in tandem with other reports that identified some plant products for their potential use as protectants due to their fungicidal properties (Shatters *et al.*, 2014; Olasan *et al.*, 2018). Destructive action of fungi that degrade food materials is attributed to enzymatic activities of the fungi. Therefore, a possible antifungal mechanism of any potential protectant should target the disruption of pathway of fungal lytic enzymes and cell wall

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components (Kareem *et al.*, 2018; Oredoyin *et al.*, 2020). The two plant extracts tested must have possessed antimicrobial properties that inhibited the ability of certain fungi to colonise cowpea seeds possibly through the mechanism reported by other authors. It thus suggests that mycotoxins produced by *Aspergillus* species and other fungi could be eliminated through the application of *S. occidentalis* and *S. palmifolia* powdered extracts in stored grains generally such as sesame and groundnut apart from cowpea. The tested plant materials may be exploited sources of cheap, safe and available materials as potential grain protectants against insects and fungal pathogens during storage.

Table 1: Mean Insect mortality @12 hours of Treatment Exposure

	FUAMPEA 1	SAMPEA 15	SAMPEA 19
SO@1g	0.0 (0.0%)	0.5 (16.7%)	0.5 (16.7%)
SO@0.5g	0.5 (16.7%)	0.5 (16.7%)	0.5 (16.7%)
SP@1g	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)
SP@0.5g	0.5 (16.7%)	0.0 (0.0%)	0.0 (0.0%)
Dress Force	3.0 (100.0%)	1.5 (50%)	1.0 (33.3%)
NT	1.0 (33.3%)	0.0 (0.0%)	0.5 (16.7%)

Legend: SO= *Senna occidentalis*; SP = *Setaria palmifolia*; NT= No treatment
F (Treatment type) = 5.58, P=0.010 ($P<0.05$); F (variety type) = 1.50, P= 0.269 ($P>0.05$)

Table 2: Mean Insect mortality @ 24 hours of Treatment Exposure

	FUAMPEA 1	SAMPEA 15	SAMPEA 19
SO@1g	0.0 (0.0%)	1.0 (33.3%)	2.5 (83.3%)
SO@0.5g	0.5 (16.7%)	2.0 (66.7%)	0.5 (16.7%)
SP@1g	0.0 (0.0%)	1.5 (50.0%)	3.0 (100.0%)
SP@0.5g	1.0 (33.3%))	0.5 (16.7%)	1.0 (33.3%)
Dress Force	3.0 (100.0%)	3.0 (100.0%)	1.0 (33.3%)
NT	1.0 (33.3%)	0.0 (0.0%)	0.5 (16.7%)

Legend: SO= *Senna occidentalis*; SP = *Setaria palmifolia*; NT= No treatment
F (Treatment type) = 1.05, P=0.441 ($P>0.05$); F (variety type) = 0.37, P= 0.70 ($P>0.05$)

Table 3: Mean Insect mortality @ 48 hours of Treatment Exposure

	FUAMPEA 1	SAMPEA 15	SAMPEA 19
SO@1g	3.0 (100.0%)	2.5 (83.3%)	3.0 (100.0%)
SO@0.5g	0.5 (16.7%)	2.0 (66.7%)	3.0 (100.0%)
SP@1g	0.5 (16.7%)	2.0 (66.7%)	3.0 (100.0%)
SP@0.5g	1.0 (33.3%))	1.5 (50.0%)	1.5 (50.0%)
Dress Force	3.0 (100.0%)	3.0 (100.0%)	3.0 (100.0%)
NT	1.0 (33.3%)	1.5 (50.0%)	1.5 (50.0%)

Legend: SO= *Senna occidentalis*; SP = *Setaria palmifolia*; NT= No treatment
F (Treatment type) = 4.16, P=0.026 ($P<0.05$); F (variety type) = 3.98, P= 0.053 ($P>0.05$)

Table 4: Mean Insect mortality @ 72 hours of Treatment Exposure

	FUAMPEA 1	SAMPEA 15	SAMPEA 19
SO@1g	3.0 (100.0%)	2.5 (83.3%)	3.0 (100.0%)
SO@0.5g	0.5 (16.7%)	2.5 (83.3%)	3.0 (100.0%)
SP@1g	0.5 (16.7%)	2.0 (66.7%)	3.0 (100.0%)
SP@0.5g	1.0 (33.3%))	2.0 (66.7%)	1.5 (50.0%)
Dress Force	3.0 (100.0%)	3.0 (100.0%)	3.0 (100.0%)
NT	1.0 (33.3%)	1.5 (50.0%)	1.5 (50.0%)

Legend: SO= *Senna occidentalis*; SP = *Setaria palmifolia*; NT= No treatment
F (Treatment type) = 3.35, P=0.049 (P<0.05); F (variety type) = 3.83, P= 0.058 (P>0.05)

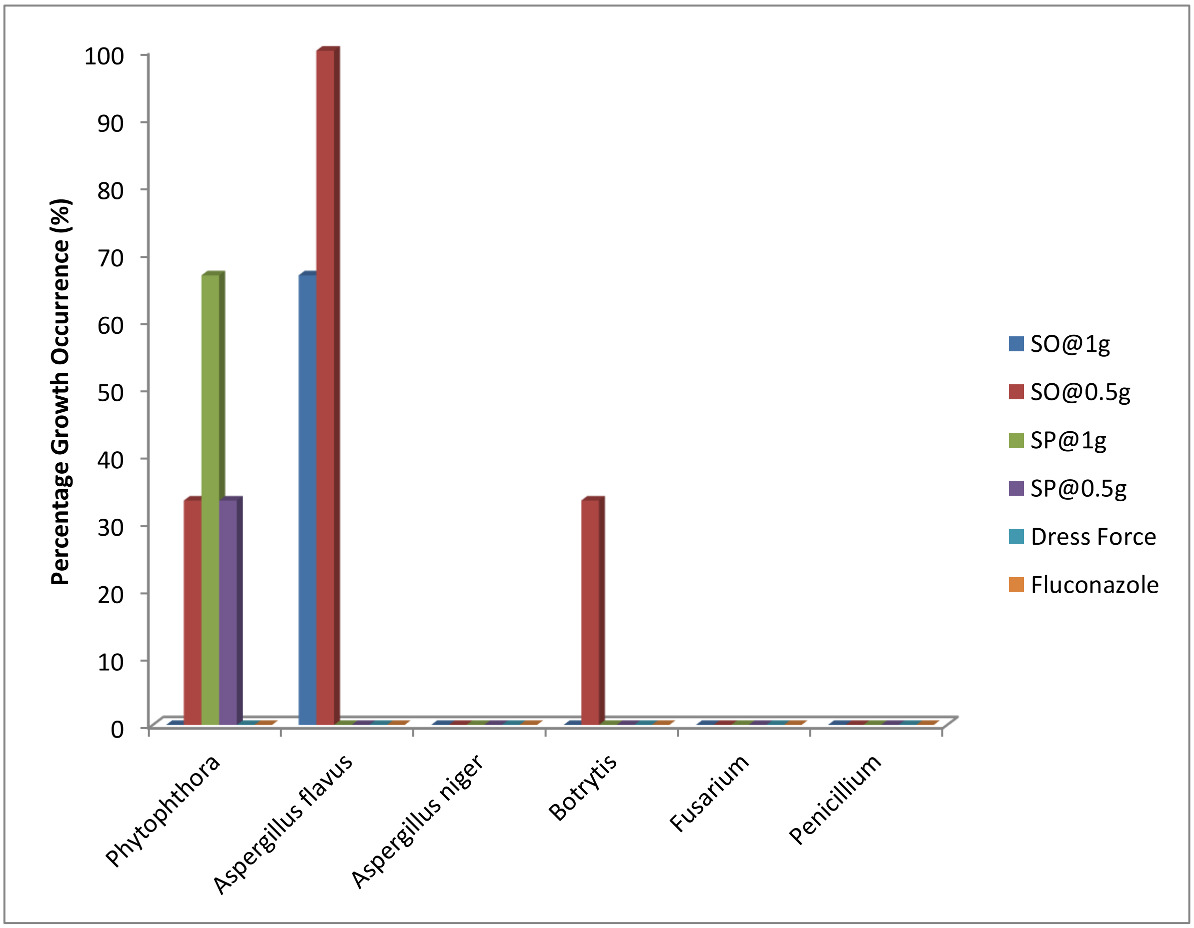

Figure 1: Relative Growth Occurrence of Fungal Growth in Treated SAMPEA-19 **Seeds at 72 hours Exposure Time**
Legend: SO= *Senna occidentalis*; SP = *Setaria palmifolia*;

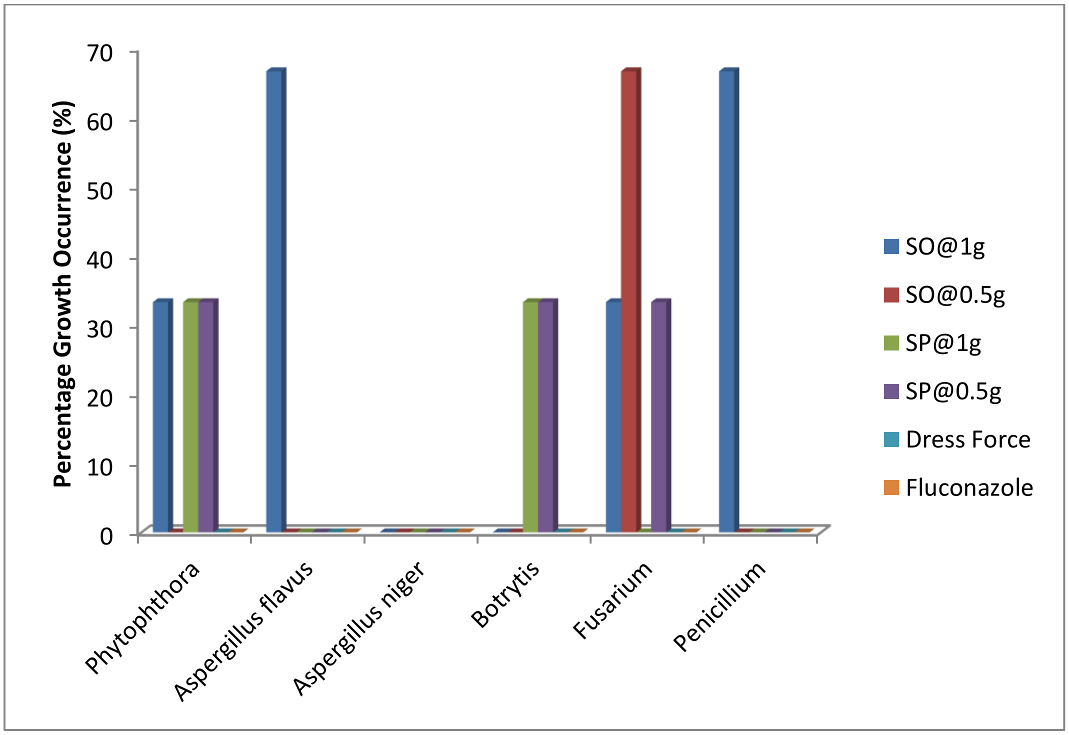

Figure 2: Relative Growth Occurrence of Fungal Growth in Treated SAMPEA-15 **Seeds at 72 hours Exposure Time**
Legend: SO= *Senna occidentalis*; SP = *Setaria palmifolia*;

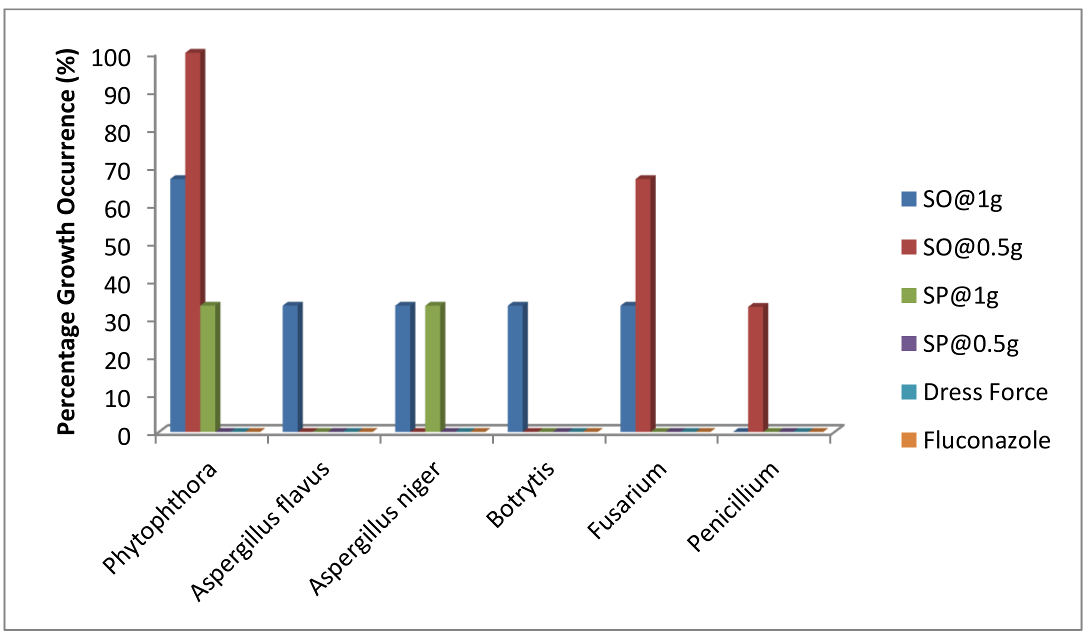

Figure 3: Relative Growth Occurrence of Fungal Growth in Treated FUAMPEA-1 Seeds at 72 hours Exposure Time
Legend: SO= *Senna occidentalis*; SP = *Setaria palmifolia*;

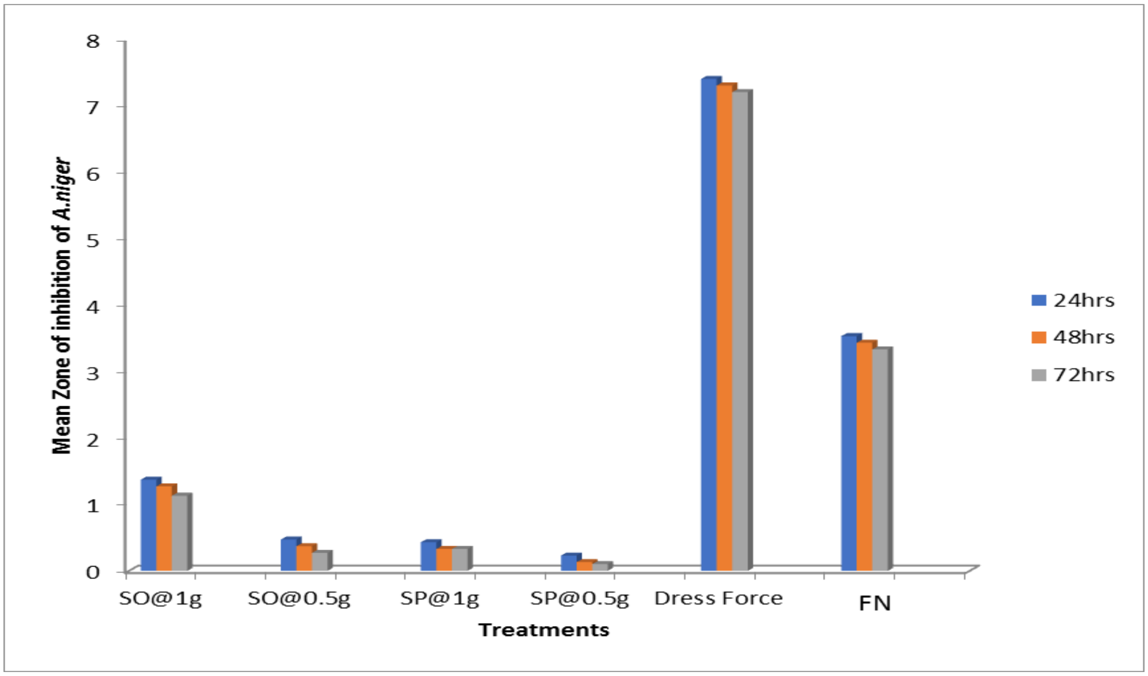

Figure 4: Comparative Inhibition of *Aspergillus niger* at Different Treatment and Exposure Time
Legend: SO= *Senna occidentalis*; SP = *Setaria palmifolia*; FN= Fluconazole

CONCLUSION

This study has confirmed that the two test plants had insecticidal and fungicidal properties that could be used in the preservation of cowpea seeds during storage. However, *S.occidentalis* performed better than *S. palmifolia* as shown in the report. It may be exploited biotechnologically in the manufacture of seed protectants subject to further improvement and evaluations. This would be cheaper and safer than the hazardous chemicals of pest control.

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