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Influence of Seed Treatment and Packaging Materials on Longevity of Pigeon Pea (*Cajanus cajan*)

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ABSTRACT: This study was carried out between January 15th to October 20th, 2019, at the University of Agriculture and Environmental Sciences Umuagwo, Nigeria. It was aimed at evaluating the effect of packaging materials and storage period on the vigor parameters of some selected pigeon pea genotypes. NSWCC-19, NSWCC-7D and NSWCC-50 were treated with four leaf extracts namely neem *(Azadiracthta indica),* bitter leaf *(Vernonia amygdalina),* pawpaw (*Carica papaya)* and scent leaf *(Ocimum gratissimum)* all at l0g/l00g. The seeds were kept in four different packaging materials: plastic cans, polythene bags, paper envelopes and glass bottles and stored for ten months at ambient conditions. Data collected were subjected to ANOVA; treatment means were separated using Duncan's Multiple Range Tests ($P < 0.05$). The study concluded that pigeon pea seed stored in glass bottle in combination with neem or pawpaw leaf powder is recommended for an effective maintenance of its seed viability and vigour.

Keywords: Leaf extracts, seedling vigour, seed quality, seedlot

INTRODUCTION

Pigeon pea (*Cajanus cajan* (L.) Millsp.) is one of the most common tropical and subtropical legumes cultivated for its edible seeds. The stems and branches are a good fuel source and basketry. Among other uses of pigeon pea, trials have shown a potential use as a raw material for paper pulp it also contributes to the environment through its use in alley cropping and as a windbreak, cover crop, shade plant and green manure (Cook *et al.,* 2005). Despite all these numerous benefits of the crop, it is still categorized as under-utilized crop in Nigeria and little information is available on seed quality potential after harvest and during storage, seed is fundamental to production of crops. After maturation and harvest, seeds have to be stored until required for planting and need to maintain nearly 100 % germinations (Elli *et al.,* 2019).

Deterioration and reduced longevity in seed is affected by enzymes activity, integrity of cell membrane, and stability of nucleic acid (Lambat *et al*., 2015). Seed deterioration is loss of seed quality, viability and vigor due to effect of adverse environmental factors (Kapoor *et al.,* 2010). Seed deterioration is an undesirable attribute in agriculture and this because, the process is cumulative, irreversible, degenerative and inexorable (Kapoor *et al.*, 2011). As the seed is hygroscopic in nature, its quality is being affected due to variations in the environmental conditions viz., relative humidity, temperature, moisture content, gaseous exchange, packaging material etc. (Dasbak *et al.,* 2015). Seed quality can be influenced by environmental factors during seed production (Shruth *et al.,* 2019), genetic make-up (Adebisi *et al*., 2008a;

Kehinde, 2018) and pest and pathogen damages in storage (Kulik, 1995;).

Seeds are stored for few days, weeks, months or year during which it deteriorates, moving inexorably towards death. Pigeon pea is orthodox in nature (the seeds of this plant can be dried to low moisture content without significantly reducing their viability). This means the seeds are suitable for long-term frozen storage). As seed moisture increases, the rate of deterioration increases (Tiwari and Kuntal, 2014), and high temperature plus high relative humidity makes seed storage much more difficult. Vanaja *et al*., (2016), Bharat *et al*. (2011) and Vales and Murdock. (2014) all reported that one of the major factors influencing seed longevity is seed moisture content of the storage environment.

Storage and preservation of seed of crop is popularly done using fungicides and pesticides of inorganic origin. Unabated application of artificial seed protectants is causing holistic damage to the ecosystem. Ideally a pesticide must be lethal to the targeted pest, but not to non-targeted beings, including human. Unfortunately, this is not the case, so the controversy of use and abuse of pesticide has surfaced. The rampant use of these chemicals caused havoc to the living forms (Vales and Murdock, 2014). Hossain *et al*., (2014) found effectiveness of tobacco leaf powder in controlling oviposition, adult emergence of *Callosobruchus chinensis* pest causing seed infestation to stored Chickpea. Rajapakse, (2006) successfully used some plants to control infestation of beetles on stored seed crops. In Nigeria, pigeon pea farmers are facing problem of preservation of seeds of this crop after harvest due to precarious environmental conditions of temperature and relative humidity. The seed of this crop is not commercially available in seed marketing outlets thereby reducing farmers' access to high quality seed and enabling them to contend with available stock of poor viability with poor seedling establishment and consequently reducing grain yield. The information on influence of seed treatment and storage containers on seed longevity of pigeon pea seeds is meager. With this in view, a comprehensive study was envisaged to know the effect of seed treatment (organic) chemicals and packaging materials on storability of pigeon pea.

MATERIALS AND METHODS

Study area

The studies were conducted at the Laboratory of the Department of Crop Production, Faculty of Agriculture, University of Agriculture and Environmental Sciences Umuagwo Owerri. The experimental design was 3x5x4 factorial CRD comprising 3 varieties, 5 storage periods and 4 packaging materials by 4 replicates. There were three factors; leaf extract, storage container, and genotypes. A total of 180 treatment units were utilized for this study.

Collection of test pulse, plants and preparation of plant part powder

Pigeon pea (*Cajanas cajan L*.) seed samples were collected from Institute of Agricultural research and training, Ibadan. The genotypes used were selected on the bases of their yield potential and physiological attributes. A basal assessment of the quality of the three pigeon pea genotypes was done prior to storage. The four treatment plants namely neem *(Azadiracthta indica),* bitter leaf *(Vernonia amygdalina),* pawpaw (*Carica papaya)* and scent leaf *(Ocimum basilicum L)*; used as bio-powder plant protectants, selected plants leaves were cut, surface sterilized with 0.1% $HgCl_2$ and washed to remove disinfectant with sterile distilled water. Each sterilized leaves parts kept for drying in hot air oven at 60^{o}C for 48 hours, dried leaf parts were crushed to powder with the help of grinder. The test leaves powders thus obtained passed through sieve to get fine powder and stored in polythene bags.

Application of plant part powders to seed of test pulse pigeon pea

The 300g seed of Pigeon pea dusted separately with 30gram (10g/100g of seeds) leaf powder of Neem leaf, Scent leaf, and Bitter leaf and Paw-paw leaf. Seeds without dusting with any plant part powder served as control. They were filled into different containers and kept in a wooden cabinet. The packed seed lots were stored at ambient conditions for 10 months. The temperature and relative humidity were monitored daily at (mean temp. 28^{o}C, RH 72.21%). Seed samples were taken from each packaged seed lots for evaluation at 60-days interval for a period of 300days to assess each for viability, vigour, moisture content and presence of insect pests.

Preparation of pigeon pea seeds into various packaging materials

400 hundred grams of pigeon pea was measured into the various packaging materials (plastic cans, polythene bags, paper envelopes and glass bottles) and then stored for ten months at ambient conditions. The packed seed lots were stored at ambient conditions for 10 months. The temperature and relative humidity were also monitored daily at (mean temp 28.3 8°C, RH 72.62%). Pigeon pea seeds were kept in four storage containers namely plastic cans, polythene bags, paper envelops and glass bottles.

The opening of the polythene bag was sealed with a sealing machine, paper bags were sealed firmly with cellotape while the plastic cans and glass bottle had airtight lids. Treatments were stored at ambient conditions for 10 months. However, during the storage period seed samples were taken every 60days from the packaging materials by taking one packaging material per sampling date. Seed samples were taken from each packaged seed lots for evaluation at 60-days interval for a period of 300days to assess each for viability, vigour, moisture content and presence of insect pests. The temperature and relative humidity of the storage environment were monitored daily throughout the storage period.

Data collection

Seed quality evaluation: Seed samples were drawn from each experimental unit at 60-day interval for seed quality evaluation (0, 60, 120,180, 240, and 300 days).

Seed viability (%)

From each treatment, 100 seeds were sown on a uniform layer of moist sand then covered to a depth of 10-20mm. The sand used was sieved to pass 0.8mm diameter, which was left loose. The sand used for the study was thoroughly washed, and sterilized at 160^0C for two hours before use, so as to be void of soil-borne disease pathogens and foreign seeds. Each of the genotypes was replicated thrice and their seeds were sown on uniform layers of moist sandy soil and moistened to 50% of the water holding capacity in an experimental bowl. The sown seeds were however covered to a depth of 20mm with sand which was left loosen. Germination counts were taken on the third, fifth and seventh day after sowing using Adebisi *et al.,* 2004 procedures. Germination was taken as clear indication of emergence of seedlings and expressed in percentage.

$$\text{Seed viability (\%)} = \frac{\text{Number of viable seeds}}{\text{Number of seeds tested}} \times 100$$

Recording of weather data: For weather data recording, the temperature and relative humidity inside the storage chamber was taken daily from the onset of the storage experiment until the experiment was terminated.

Data analysis

The data collected from the experiment were analyzed using SAS (Statistical Analysis Software) version 9.1. (SAS, 1999). Analysis of variance (ANOVA) was carried out with storage container, genotype and seed treatment as factors, in order to be able to determine if the storage container, genotype and treatment were significant on the parameters evaluated. Means from ANOVA were separated using Duncan Multiple Range Test (DMRT), in order to detect differences among the containers, genotypes and the seed treatments. Correlation analysis was carried out on the parameters evaluated to ascertain the kind (s) of association that exist among the seed quality attributes.

RESULTS

At zero days after storage, no significant difference was recorded among the treatments as all the three genotypes were the same statistically (100%) in terms of seed viability (Table 1). However, at 60 days after storage, the effect of genotypes did differ significantly. Genotype NSWCC-50 had the highest seed viability up to 300DAS of storage. When compared to the other two genotypes, NSWCC-50 had germination percentage of 80.5% at tenth months while NSWCC-7D gave a lower seed viability of 69.8% at the end of 300 days after storage of storage (Table 1).

Seed treatments with botanical extracts did not differ significantly in their effects on seed viability from zero up to 120 days after storage, but differed significantly from 180 to 300 days after storage. After 300 days after storage, seeds treated with neem powder had the highest seed viability 77.8 % while the control gave the least of 68.3 % for seed viability when compared with the other treatments.

Significant differences in viability of seeds stored in various packaging materials were observed starting from the 60 to 300 days after storage of storage. For instance, viability of seeds stored in paper envelopes ranged from 96.5- 20.5% which was the lowest when compared to those stored in glass bottles, polythene bags and plastic cans. The viability of seeds stored in glass bottles at 120, 240 and 300 days after storage were higher than those in other packaging materials.

The combined effects of seed treatments and packaging materials on the three pigeon pea genotypes between 0 and 180 days after storage was presented in (Table 2). At zero days after storage, all the genotypes were statistically the same with seed viability of 100% while similar result was obtained at 60 DAS. However, at 120days after storage, only seven treatments had 100% germinability and they were recorded in all the treatments that involved the glass bottle, polyethen bags that involved seeds stored with neem and pawpaw powders with plastic can without any treatment.

The combined effects of seed treatments and packaging materials on the three pigeon pea genotypes

Table1: Mean performance of seed treatment and packaging materials on seed viability of three genotypes of pigeon pea at different storage period under ambient conditions.

Genotype	DAS 0	DAS 60	DAS 120	DAS 180	DAS 240	DAS 300
NSWCC-7D	100.0a	96.3a	93.3b	89.3 c	76.6b	69.8c
NSWCC-19	100.0a	95.4b	94.0ab	94.9b	90.8a	79.5b
NSWCC-50	100.0a	96.6a	97.6a	92.5a	80.8a	80.5a
SE	0	0.07	0.09	0.13	0.21	0.20
Treatment						
Control	100.0a	96.0a	93.5a	87.6c	73.7b	68.3c
Bitter	100.0a	95.5a	94.1a	90.8b	80.5a	75.1b
Scent	100.0a	96.4a	93.9a	91.6ab	81.6a	75.1b
Pawpaw	100.0a	96.4a	93.3a	91.2b	79.1a	76.6ab
Neem	100.0a	96.2a	94.1a	91.3 a	82.0a	77.8a
SE	0	0.14	0.18	0.08	0.12	0.11
Container						
Envelope	100.0a	96.5b	94.8c	82.5c	40.0c	20.5c
Glass bottle	100.0a	100.0a	100.0a	96.9a	96.3a	96.0a
Polythene	100.0a	99.5a	97.0b	94.3b	94.1b	93.0b
plastic can	100.0a	99.3a	96.2b	95.0a	92.5b	92.0b
S.E	0	0.06	0.07	0.11	0.16	0.14

DAS- days after storage. mean with the same letter along the column are not significantly different from one another according to Duncan Multiple Range Test (DMRT) at 5% probability level

Table 2: The combined effects of seed treatments and packaging materials on the three pigeon pea genotypes between (0-120) DAS of storage.

		Germinability % in storage container		
Genotype	**Plant extracts**	Effect at 0 and 60 days after storage		
NSWCC-7D		**Glass bottle**	**Polyethene bag**	**Plastic can**
	Neem leaf powder	100	100	100
	Pawpaw leaf powder	100	100	100
	scent leaf powder	100	100	100
	control	100	100	100
NSWCC-19				
	Neem leaf powder	100	100	100
	Pawpaw leaf powder	100	100	100
	scent leaf powder	100	100	100
	control	100	100	100
NSWCC-50				
	Neem leaf powder	100	100	100
	Pawpaw leaf powder	100	100	100
	scent leaf powder	100	100	100
	control	100	100	100
		Effect at 120 days after storage		
NSWCC-7D		**Glass bottle**	**Polyethene bag**	**Plastic can**
	Neem leaf powder	100	100	80
	Pawpaw leaf powder	100	100	70
	scent leaf powder	100	80	80
	control	100	90	100
NSWCC-19				
	Neem leaf powder	75	75	70
	Pawpaw leaf powder	80	70	80
	scent leaf powder	80	70	80
	control	70	65	60
NSWCC-50				
	Neem leaf powder	65	60	80
	Pawpaw leaf powder	70	70	75
	scent leaf powder	75	70	80
	control	60	65	75

Table 3: The combined effects of seed treatments and packaging materials on the three pigeon pea genotypes between (180- 300) DAS of storage.

		Germinability % in storage container		
Genotype	**Plant extracts**	**Effect at 180 days after storage**		
NSWCC-7D		**Glass bottle**	**Polyethene bag**	**Plastic can**
	Neem leaf powder	100	100	80
	Pawpaw leaf powder	100	70	70
	scent leaf powder	100	80	80
	control	80	85	80
NSWCC-19				
	Neem leaf powder	100	75	80
	Pawpaw leaf powder	100	70	70
	scent leaf powder	100	70	80
	control	70	65	70
NSWCC-50				
	Neem leaf powder	100	60	80
	Pawpaw leaf powder	100	70	75
	scent leaf powder	100	70	80
	control	60	65	75
NSWCC-7D		**Glass bottle**	**Polyethene bag**	**Plastic can**
	Neem leaf powder	100	85	80
	Pawpaw leaf powder	100	70	70
	scent leaf powder	100	70	80
	control	80	70	80
NSWCC-19				
	Neem leaf powder	100	75	70
	Pawpaw leaf powder	100	60	80
	scent leaf powder	100	60	80
	control	70	60	60
NSWCC-50				
	Neem leaf powder	100	60	80
	Pawpaw leaf powder	100	70	75
	scent leaf powder	100	15	80
	control	70	15	75

between (180- 300) DAS of storage is presented in (Table 3). At 180 days after storage, genotype NSWCC-7D seeds treated with neem leaf powder, pawpaw leaf powder, scent leaf powder stored in glass bottles, seeds treated with neem leaf powder stored in polythene bags and seeds without treatment stored in plastic cans had 100% germination values while the rest treatment reduced drastically, the least was recorded in poly ethane bag with no treatment at all. Similar result was recorded at 240 days after storage, genotype NSWCC-19 seeds treated with bitter leaf powder and neem leaf powder stored in glass bottles and seeds treated with bitter leaf powder stored in polythene bags were the most effective as they had the highest viability values of 100%. Conversely genotype NSCC-50 of seeds without treatment control stored in paper envelopes was significantly lower viability values of 65%.

At 300 days after storage, the combined effects of seeds treatment, genotypes and packaging materials were highly significant (P< 0.05). NSWCC-7D seeds treated with bitter leaf powder, neem leaf powder, pawpaw leaf powder stored in glass were observed with same values of 100% while NSWCC-50 seeds treated with neem leaf powder, pawpaw leaf powder and scent leaf powder stored in glass bottle as well, had same values of l00% (Table 3). However, among the treatments NSWCC-7D seeds of all seed treatments stored in paper envelopes clearly indicated a significant reduction of 15% viabilities.

DISCUSSION

Storage period is an important stage in the seed production process, the preservation of seed during this process, that is, from harvest time to the time of its use is an essential aspect to be regarded in the production process, because the effort spent in the production phase may not be effective if the seed quality is not maintained (Oliviera *et al*., 1999; Adebisi, *et al*., 2019). Also, the utilization of high quality seed lot constitutes one of the major factors responsible for successful crop production.

All the plant extracts used in this study revealed that they all have the potential to protect seeds in storage. However, the neem leaf powder performed best. Umesha *et al.* (2017) observed that in cluster bean seeds coated with neem leaf powder showed excellent control of the insect infestation and prolonged the seed longevity and maintained better seed health throughout the storage period. Glass bottle was the best packaging material used in this study. This finding agrees with the report of Khalequzz *et al*. (2012) in French beans, Kehinde *et al.,* (2018) in pigeon pea. Also, Daniel *et al. (*2012) in maize seeds, Verma, (2014) and Obute *et al.* (2019) both in soybean used several containers for storage but in all, glass bottle had the better seed longevity, followed by plastic can. However, seeds stored in gunny bags lost viability after 300 days after storage of storage.

Conclusion

The result obtained from the present study suggests that glass bottles is a better material for pigeon pea storage than plastic cans, polythene bags, paper envelopes under ambient condition storage. Treating the seeds with neem leaf powder is most effective for maintaining good seed viability up to 300 days after storage. Storage of pigeon pea seed in glass bottle in combination with neem or pawpaw leaf powder has an effective maintenance of seed viability. Envelope is not ideal for pigeon pea seed storage for long time, because seed stored in air tight containers maintained desired seed quality than non-airtight packaging materials.

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