

EVALUATION OF THE SEED-DRESSING POTENTIALS OF PHYTOCHEMICALS FROM
Carica papaya and *Piper guineense* ON THE GERMINATION OF COWPEA (*Vigna unguiculata*
L. Walp) SEEDS AND INCIDENCE OF THE SEED-BORNE FUNGI

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ABSTRACT

Cowpea is the most important grain legume in Nigeria. The crop plays a soil fertility restorative role in farming systems. Its protein-rich grains are widely consumed and the haulms are fed livestock. However, its production is constrained by fungal attacks at all stages of its growth, amongst other socio-economic factors. Some of these diseases which affect the crop are seed-borne and seed transmissible. Their control has been by use of synthetic fungicides. But these are associated with discouraging drawbacks on human and eco-health. Alternatively, plant extracts are being screened as sources of novel fungicides. This study evaluated *in vitro* two concentrations (30% and 50%) of extracts from *Carica papaya* (roots, seeds, leaves) and *Piper guineense* (seeds, leaves) as seed-dressing phytochemicals on the germination of cowpea seeds and the incidence of the seed-borne fungi. The seeds were soaked in each concentration of the crude aqueous extracts for 12 hr, removed and air-dried at room temperature for 8hr. The treated seeds were then plated on solidified PDA in Petri dishes and incubated for 7 days in the inoculation chamber. The dishes were arranged in completely randomized design (CRD), made up of 6 treatments and 5 replicates giving 300 seeds for each concentration. The results showed generally that the germination profile was better ($p < 0.05$) at the 30% rate of application than 50%. Regardless of dosage of treatment, cowpea seeds dressed in *Carica papaya* root extracts gave 100% germination while those treated with *Piper guineense* failed to germinate. This study also affirmed that species of *Fusarium*, *Colletotrichum*, *Curvularia*, *Mucor* and *Aspergillus* were associated with seeds of cowpea variety IAR-48. It indicated that *C. papaya* root and *P. guineense* seed extracts significantly ($p < 0.05$) gave a better reduction of these seed-borne fungi. At 30% concentration, the mean incidences were 19.20% and 4.80% while 5.20% and 0.00% were obtained from 50% dosage respectively. Though 50% concentration of the extracts generally gave a higher reduction of the fungal load in the cowpea seeds, in other words a better control of the organisms, the germination of the treated seeds were significantly ($p < 0.05$) better with 30% concentration. Hence, aqueous root extracts of *C. papaya* could be used as effective seed-dressing phytochemical in IPM programmes for the control of seed-borne fungi of cowpea for improved productivity. However, *P. guineense* seed extracts should be tried out in further studies to determine their seed-safe levels or application methods.

KEYWORDS: Seed-borne fungi, Phytochemicals, Germination, *Carica papaya*, *Piper guineense*, IPM

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INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp), is one of the most important legumes in the world. It is reported as the second most important pulse crop in Africa after common bean (*Phaseolus vulgaris* L.) and the most important grain legume in Nigeria (Gibbon and Pain, 1991; Abate *et al.*, 2011). The grain contains 23-32% protein by seed weight and other nutrients such as beta-carotene, thiamine, riboflavin, niacin, vitamin A, folic and ascorbic acids which greatly improve unbalanced diets (Amusa *et al.*, 1994; Aveling, 2007; Timko *et al.*, 2007). The crop is a source of fodder and haulms for livestock. It acts as a restorative cover crop in arable and marginal lands, fixing on the average 200kgN/ha per year by symbiosis with *Bradyrhizobium* bacteria (FAO, 1994; Awurum, 2000; Awurum *et al.*, 2001; SADAFF, 2009).



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Statistics show that Nigeria produces 2.0 million MT of its grains annually on 5 million ha of farmlands. Consumption per capita of this valuable grain stands at about 30kg per annum (Singh *et al.*, 2002). The National Bureau of Statistics (NBS) of the Government of Nigeria projected that by 2015 domestic production of cowpea grains will rise to 3.364 million MT. However, the production of this important crop is infringed and constrained by heavy fungal disease attacks including seed and foliar decimating diseases at all stages of its growth amongst other socio-economic factors, leading to low yields especially in Africa and Asia (Awurum *et al.*, 2000; Ajibade and Amusa, 2001; Abate *et al.*, 2011). According to the NBS, the projected demand for cowpea grains within this period would outstrip its production by 1.91 million MT. Cowpea is seed-established. The need for clean seeds for improved production to meet national demands are already glaring. In field experiments, anthracnose, brown blotch, sphaceloma scab and septoria leaf spots affected the crop in the humid Southeast Nigeria (Awurum, 2000; Awurum *et al.*, 2001). These diseases are seed-borne and seed transmissible. Seed-borne fungi affect seed health. They cause damage such as flower and pod abortion, shrunken seeds, seed necrosis and discolouration. Their metabolites such as aflatoxin and mycotoxins affect seed viability, seed germination and seedling vigour. For instance, *Aspergillus rubber* toxins had been implicated to inhibit the germination of pea seeds. Species of *Colletotrichum*, *Ascochyta* and *Macrophomina* caused seed rot in legumes (Shetty, 1992). In Nigeria for example, sphaceloma scab resulted in complete crop loss in cowpea in the savannas of the North (Emechebe and Florini, 1997). Other species such as *Fusarium*, *Diplodia*, *Botrytis* and *Botrydiplodia* had been linked with seed rot and deterioration of food reserve in several seeds (Shetty, 1992). In the overall, these lead ultimately to reduction of grain yield in the affected crop (Sinclair, 1981; Shetty, 1992).

Furthermore, Emechebe and Florini (1997), reported that in the savannas of Nigeria, between 65-75% grain yield reductions have been attributed to attacks from seed-borne fungal organism such as *Septoria vignae* (Septoria leaf spot), *Colletotrichum capsici* (brown blotch), *Elsinoe phaseolina* (sphaceloma scab) while in the humid rain-forest agro-ecological zone of the country, *C. destructivum* (anthracnose) has been underpinned for up to 50% loss in grain yield in cowpea. Seeds transmit pathogens into pathogen-free locations. Surveys showed that up to 88% of bean seed samples from India were infected with *Colletotrichum lindemuthianum* and that the fungus was introduced into Pakistan on infected seeds from Nigeria (Emechebe and Florini, 1997).

To maximize yield in cowpea production, cowpea seeds therefore should be clean and disease-free. Emechebe (1981) reported that reduction of fungal inoculum on seeds through seed treatment would offer a cheap and effective method for their control. Synthetic chemicals have been used to control seed-borne fungal diseases. However, in several scientific reports, they have been linked with many undesirable side effects on human and ecological health. Multi-site fungicides such as thiram and captan used to treat large volumes of seeds have been banned in the USA and Europe due to mammalian toxicity (Taylor and Harman, 1991). Recently FAO reported 150 fungal pathogens resistant to fungicides (Par and Rajul, 1994), with *Colletotrichum spp.* noted as tolerant or resistant to some of the most effective fungicides such as thiophenate- methyl, carbendazim and benomyl (Emechebe and Florini, 1997). These drawbacks impressed the need for alternatives.

In Plant Pathology these days, higher plants are being screened as sources of novel chemotherapeutants for plant health management. The effectiveness of these phyto-chemotherapeutants against a broad array of pathogens has been established by many workers (Awurum, *et al.*, 2005; Awurum, 2010; Enyiukwu and Awurum, 2011; 2012). Earlier reports from Owolade and Osikanlu (1999) indicated that *Acalpha ciliata* and *Ocimum gratissimum* as seed-dressing preparations had significant fungitoxic activity against brown blotch (*C. capsici*) in cowpea in the glasshouse. Disease control through clean seeds has been identified as a veritable and practicable management technique when seed-borne inoculum is the primary and main source of outbreak of the disease in seedlings (Beseri, 1992; Hewitt, 1992). Hence, this study evaluated the seed-dressing potentials of phytochemicals from *Carica papaya* and *Piper guineense* on the germination of cowpea seeds and their effects against the seed-borne fungi.

MATERIALS AND METHODS

Sources of seeds and plant materials

The experiment was conducted in the Crop Science laboratory of Michael Okpara University of Agriculture, Umudike. The seeds of cowpea variety IAR-48 were obtained from the Research and Training Unit of the University; and fresh plant materials (*Carica papaya* seeds, roots and leaves, *P. guineense* leaves) from the



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University neighbourhood as well as dried (*Piper guineense* seeds) obtained from Umuahia main market, were used in the study. The mean ambient parameters of the study area were 2163mm of rainfall, temperature 20-30°C and relative humidity 57-87% per annum.

Preparation of plant extracts and culture medium

Fresh leaves, roots and seeds of *Carica papaya* and fresh leaves of *Piper guineense* were washed thoroughly in tap water and rinsed in three changes of sterile distilled water and then air-dried on the laboratory bench at room temperature of 27° C. Thereafter 30g and 50g of each specimen of the plant materials were weighed out and ground separately into paste in 100mL of sterile distilled water, using an electric blender (Model: LG-914). Each paste thus prepared was allowed to stand in 200mL beaker for 1 hr. Also 30g and 50g respectively of the dried *Piper guineense* seeds were weighed out and each ground into powder. Each powder was put into a 200mL beaker to which 100mL of sterile distilled water was added and allowed to stand for 1hr. At the end of the hour, the pastes were strained through 4-folds of sterile cheese cloth to obtain filtrates of 30% and 50% strengths of the plant materials. Then 200g of fresh peeled Irish potato was boiled in 1L of water contained in 2L flask for 1hr. The broth was filtered through double-folds of sterile cheese cloth, made up to 1L with sterile distilled water to which 20g agar and 15g glucose were added. The broth was modified with 20mg of Gentamicin (an antibiotic to kill or suppress any bacteria contaminating the medium) and stirred vigorously with a glass stirrer. The flask was stoppered with foiled cotton wool and then autoclaved at 120° C and 760mmHg for 30 minutes.

In vitro experiment

Fifty (50) cowpea seeds (Var.IAR-48) were soaked in each aqueous suspension of the respective strengths (30% and 50%) of the filtrates of the plant materials for 12 hr., removed and air-dried at room temperature (27° C) for 8 hr. The control was set up in a similar manner but consisted of cowpea seeds soaked in sterile distilled water for the same length of time. About 20mL of PDA was poured aseptically into each Petri dish in the inoculation chamber and allowed to solidify for 2 hr. At the end of this period, 10 seeds soaked in a particular type and strength of plant extract were then plated in the Petri dishes and incubated for 5 days at 27° C, and then observed for germination and mycelial growth. Ten (10) cowpea seeds were plated per Petri dish per replicate. The whole experiment was repeated twice giving 50 seeds per treatment and 300 seeds for each set of a particular concentration. The Petri dishes were arranged in a completely randomized design (CRD) in the inoculation chamber. At the end of 5 days, counts of germinated seeds were taken per plate and means of replicates recorded. Records of the seed-borne fungi that grew out of the seeds and sporulated were also taken.

Pure cultures of the mycoflora associated with the cowpea seeds were obtained by repeated sub-culturing of the organisms on solidified 20mL PDA in the Petri dishes. Using a sterile needle, bits of each seed-borne fungus were transferred on glass slides, stained with a drop of lactophenol in cotton blue, teased gently and covered with cover slips. The slides were fixed by gently passing over a spirit lamp flame, then mounted on the stage of a microscope, observed and the identity of the various mycoflora confirmed through their spore characteristics by the aid of fungi identification manual by Banett and Hunter (1983).

The percentage incidence of the seed-borne fungi on the incubated cowpea was assessed as:

$$\% \text{ incidence} = \text{Number of seeds infected} / \text{Total number of seeds examined} \times 100/1$$

The percentage germination of the incubated cowpea seeds was also assessed as:

$$\% \text{ germination} = \text{Number of infected seeds} / \text{Total number of seeds examined} \times 100/1$$

STATISTICAL ANALYSIS

All measurements collected from this study were replicated 5 times and were analyzed by simple percentages and analysis of variance (ANOVA) at 5% level of significance. The Duncan's New Multiple Range Test (DNMRT) at $p < 0.05$ was applied to assess the difference amongst the means.



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RESULTS

The germination profile of the treated cowpea seeds is depicted in Table 1. At both concentrations, *C. papaya* treated seeds gave 100% germination while seeds subjected to *P. guineense* treatments failed to germinate irrespective of the concentration of treatment applied. In general, greater ($p < 0.05$) germination was obtained from seeds treated with 30% strength of the extracts than 50%.

Table 1: Effects of the plant materials on the germination of the treated cowpea seeds.

Plant materials	Germination of treated cowpea seeds	
	30% Concentration	50% Concentration
<i>Carica papaya</i> leaf	50 ^b	28 ^b
<i>Piper guineense</i> seed	0 ^c	0 ^d
<i>Carica papaya</i> seed	50 ^b	24 ^b
<i>Piper guineense</i> leaf	52 ^b	10 ^c
<i>Carica papaya</i> root	100 ^a	100 ^a
Sterile distilled water	100 ^a	100 ^a

*Data are means of 5 determinations from two separate experiments. Values on the same column having the same superscript are not significantly different at $p < 0.05$

The results also indicated that species of *Fusarium*, *Colletotrichum*, *Curvularia*, *Mucor* and *Aspergillus* were commonly associated with the seeds of cowpea variety IAR-48; and that *Colletotrichum spp.* were the most commonly isolated organisms. The inhibitory effects of the plant extracts against the various fungal organisms associated with the seeds of IAR-48 are shown in Table 2. *Carica papaya* treatments reduced the fungal inoculum load on the cowpea seeds to 19.20% and 5.20% at both strengths respectively. *Piper guineense* gave 4.80% and 0.00% at both rates respectively and these did not differ ($p < 0.05$) statistically from the values obtained from *C. papaya* root treatments Table 2. However, they differ significantly ($p < 0.05$) from the fungal load on the control (sterile water treated seeds) which have 56.00% and 54.80% respectively.

Table 2: Effects of the plant materials on the seed-borne fungal inoculum on the treated cowpea seeds.

Incidence (%) of the seed-borne organisms													
		<i>Fusarium sp.</i>		<i>Colletotrichum sp.</i>		<i>Curvularia sp.</i>		<i>Mucor sp.</i>		<i>Aspergillus sp.</i>		Mean	Mean
Plant materials		30%	50%	30%	50%	30%	50%	30%	50%	30%	50%	30%	50%
<i>Carica papaya</i> leaf	Mean	52 ^a	28 ^a	44 ^a	32 ^{abc}	44 ^a	24 ^a	30 ^a	6 ^{ab}	24 ^{ab}	20 ^{ab}	38.80 ^a	29.60 ^c
<i>Piper guineense</i> seed	Mean	0 ^b	0 ^b	12 ^b	0 ^c	0 ^b	0 ^b	8 ^c	0 ^c	4 ^c	0 ^c	4.80 ^c	0.00 ^d
<i>Carica papaya</i> seed		40 ^a	20 ^b	40 ^a	16 ^{bc}	40 ^a	6 ^b	18 ^a	8 ^b	16 ^{bc}	16 ^{ab}	30.40 ^b	17.20 ^{bc}
<i>Piper guineense</i> leaf		40 ^a	30 ^b	48 ^a	36 ^{ab}	36 ^a	2 ^b	28 ^a	14 ^{ab}	20 ^{bc}	6 ^c	34.40 ^a	20.40 ^c
<i>Carica papaya</i> root		16 ^b	4 ^c	16 ^b	8 ^c	14 ^b	2 ^b	14 ^a	8 ^b	18 ^{bc}	4 ^c	19.20 ^c	5.20 ^{cb}
Sterile distilled water		56 ^a	58 ^a	58 ^a	56 ^a	52 ^a	52 ^a	56 ^a	58 ^a	58 ^a	50 ^a	56.00 ^a	54.80 ^a



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DISCUSSION

The extracts demonstrated significant effects on the germination of the cowpea seeds. *Carica papaya* root treated cowpea seeds showed 100% germination at both rates of application. This suggested that the extract was non-phytotoxic. However, the failure of *Piper guineense* seed treated cowpea to germinate indicated that both rates of application were phytotoxic. In this regard, this finding does not agree with the findings from Awurum and Uchegwu (2013) where *P. guineense* seed powder films applied on cowpea seeds improved the seed germination from 14% in the control to 33.30% in the treated seeds. Hence, this further lends suggestion that the observed phytotoxicity may have been occasioned by not only the levels of application but also by methods of seed treatment. It follows perhaps that, in the aqueous medium, the active ingredients were readily available in solution, unlike in the powder where the active principles may still be locked up and released slowly from the solid state. Thus, this may explain the reason for the observed differences in effects of *Piper guineense* on the germination of the treated cowpea seeds by the investigators. This study also affirms the finding of Awurum and Uchegwu (2013), that species of *Fusarium*, *Colletotrichum*, *Curvularia*, *Mucor* and *Aspergillus* were commonly associated with the seeds of cowpea variety IAR-48; and that *Colletotrichum spp.* are the most commonly isolated organisms. Furthermore, the extract treatments also had significant effects on these seed-borne organisms. The best reductions of the mycoflora at both concentrations were obtained from *P. guineense* seed treatments though these were not statistically ($p>0.05$) different from the effects obtained from *C. papaya* root treatments. In this respect however, the observed effects of *P. guineense* seed extracts in the reduction of seed-borne fungal inoculum on cowpea seeds agrees with the reports of Awurum and Uchegwu (2013), where powder films of the extracts on stored cowpea reduced the seed-borne fungal load from 53.20% to 11.10% in less than 3 months.

Owolade and Osikanlu (1999) demonstrated that slurry and aqueous preparations of *Acalypha ciliata* and *Ocimum gratissimum* applied as seed treatment inhibited the transmission of brown blotch (*Colletotrichum capsici*) to cowpea seedlings. Similarly, Suprpta and Khalimi (2009) reported that in treated cuttings, formulations from *Eugenia aromatica* and *Piper betle* applied as seed and soil amendments suppressed the expression of stem rot (*Fusarium oxysporium f. sp. vanillae*) on vanilla seedlings. The finding from this study is also in consonance with these reports. Though a 100% germination was noted from the control in this study with a mean fungal load of 56%, it suggested that the microorganisms may be borne externally on the cowpea seed coats, and may not as yet have permeated to the seed embryo. However, these fungal organisms identified from this study pose a serious threat to sustainable cowpea production. They can be stimulated by exudates, metabolites and other rhizosphere conditions to incite diseases on the germinated seedlings. For example, species of *Colletotrichum*, *Fusarium* and *Aspergillus* had been implicated in several studies in not only causing seed rot and reduced germination but also to have suppressed seedling vigour, induced flower and pod abortion, seed necrosis and discolouration, as well as caused seeds to shrink in the affected legumes (Sinclair, 1981; Keswani, 1992; Shetty, 1992). Since cowpea is seed established, use of clean, disease-free seeds will go a long way in minimizing losses arising from transmission of seed-borne diseases to seedlings.

CONCLUSION

This study shows that extracts of *Carica papaya* root and *Piper guineense* seed are possible sources of alternative fungicides. They, especially *C. Papaya* root can be used by resource-poor growers to dress cowpea seeds against seed-borne fungal species as *Aspergillus*, *Curvularia*, *Mucor*, *Fusarium* and *Colletotrichum* in IPM programmes without hampering the viability and germinability of the treated cowpea seeds in order to improve the production of this valuable grain to meet national demands. However, further research is necessary to determine seed-safe levels or application methods for *P. guineense* seed extract which also showed strong fungicidal activity against these seed-borne fungal organisms.

REFERENCES

- Abate, T., Ajeigbe, H., Bouker, O., Fatokun, C., Kamara, A., Ndjeunga, J. and Ntere, B. (2011). Grain legumes of Nigeria. In: Bulletin of Tropical Legumes. A monthly publication of the Tropical Legumes II Project No 12, Dec., 2011.
- Ajibade, S. R. and Amusa, A. N. (2001). Effects of fungal diseases on some cowpea lines in the humid environment of South Western Nigeria. *Journal of Sust. Agric. Environ* 2(3): 246-253.



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Aveling, T. (2007). Cowpea Pathology Research. Pretoria South, Africa. Pp 1-7.

Awurum, A. N. (2000). Effect of planting date on the incidence and severity of some fungi diseases of cowpea in the humid tropics of Southeast Nigeria. *J. Sust. Agric. Environ* 128-133.

Awurum, A. N. (2010). Effects of extracts of some plants on wet rot of *Amaranthus hybridus* L. induced by *Choanephora cucurbitarium* and on the performance of the crop. *International Journal of the American Phytopathological Society* Vol.100, No 6, APS Meeting Abstract P9.

Awurum, A. N. and Uchegwu, P. O. (2013). Effects of duration of storage of *Piper guineense*, *monodora myristica* and *Xylopia aethiopica* on the germination and incidence of seed-borne fungi of stored cowpea (*Vigna unguiculata* L.Walp) seed. *Continental Journal of Agric. Sciences (In Press)*

Awurum, A. N., Emechebe, A. N. and Amadioha, A. C. (2001). Effect of planting date on the incidence and severity of some fungi diseases of cowpea in the humid tropics of Southeast Nigeria. *J. Sust Agric. Environ* 3(1): 31 – 38.

Awurum, A. N., Okwu, D. E. and Onyekoro, P. O. (2005). *In vitro* and *in vivo* control of *Colletotrichum destructivum* in cowpea using some plant extracts. *Journal Sci., Tech and Env.* 5(1-2): 52 – 57.

Barnett, H. L and Hunter, B. B. (1983). Illustrated Genera of Imperfect Fungi (3rd Ed). Burgess Publishing Co., Minneapolis, MN Pp 16.

Beseri, M. (1992). New trends in the control of fungal diseases. In: Seed Pathology. Mathur, S. B. and Johs Jorgensen (Eds). CTA Press, Holland Pp 303-312.

Enyiukwu, D. N. and Awurum, A. N. (2011). Effects of phytochemicals from *Carica papaya* roots and seeds and *Piper guineense* seeds on the germination of spores of *Colletotrichum destructivum*. *Continental Journal of Biological Sciences* 4(20): 55 – 59.

Enyiukwu, D. N. and Awurum, A. N. (2012). Comparative fungitoxicity of benomyl and extracts of *Carica papaya* roots and seeds and *Piper guineense* seeds on *Colletotrichum destrucivum* O'Gara. *Continental Journal of Biological Sciences* 6(1): 38-42.

Emechebe, A. M. (1981). Brown blotch of cowpea in Nigeria. *Samaru Journal of Agricultural Resources* 1(2): 21-26.

Emechebe, A. M. and Florini, D. A. (1997). Fungal and bacterial diseases of cowpea. In: Advances in Cowpea Research. Singh, R. S., Morgan-Raj, D. and Jackai, L.E.N (Eds). IITA, 176 – 183.

FAO (Food and Agricultural Organization) (1994). Legume Inoculants and their Use. FAO-UN Publication, Pp 1-7.

Gibbon, D. and Pain, A. (1991). Crops of the drier regions of the tropics. Longman, UK. P. 111

Hewett, H. (1992). The control of seed-borne fungi in England and Wales. In: Seed Pathology. Mathur, S. B. and Johs Jorgensen (Eds). CTA Press, Holland. Pp 75-83.

Keswani, C. L. (1992). Seed-borne diseases in Eastern and Southern Africa. In: Seed Pathology. Mathur, S. B. and Johs Jorgensen (Eds). CTA Press, Holland. Pp 41-52.

NBS (National Bureau of Statistics) of the Government of Nigeria (2011). Important Crops of Nigeria. www.nigeriastat.gov.ng



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Owolade, B. F. and Oshikanlu, Y.O.K (1999). Evaluation of some plant extracts for the control of brown blotch disease of cowpea in Southwest Nigeria. *J. Sust. Agric. Environ.* 1(2): 198 - 202.

Par, Pinstup-Anderson and Rajul, Pandya-Lorch (1994). Alleviating poverty, Intensifying Agriculture and Effectively Managing Natural resources- a Food, Agriculture and Environmental Discussion Paper. Washington DC Vol. 20, Pp 13-14.

SADAFF (South Africa Department of Agriculture, Forestry and Fisheries) (2009). Production Guild-lines for Cowpeas. DAIS, Pretoria, South Africa. Pp 1-15.

Shetty, H. S. (1992). *Different types of damage to seeds caused by seeds-borne fungi*. In: Seed Pathology Mathur, S. B. and Johs Jorgensen (Eds). CTA Publ., Holland. Pp 53-64.

Sinclair, J. B. (1981). Fungicide sprays for the control of seed-borne pathogens of rice, soybean and wheat. *Weed Science and Technology* 9: 697-705.

Singh, B. B. (2005). Cowpea (*Vigna unguiculata* (L.) Walp). In: Singh R. J. and Jauhar, P. P. (Eds). Genetic Resources, Chromosome Engineering and Crop Improvement vol. 2, CRC Press, Boca Raton, Florida USA. Pp 117-162.

Suprpta, D. N. and Khalimi, K. (2009). Effects of plant extracts formulation to suppress stem rot disease of vanilla seedlings. *ISSA journal* 15: 34 – 41.

Taylor, J. S. and Harman, U. M. (1991). Biological Control of Soil-borne Pathogens. Hornby, F. (Ed). Longman, London UK. Pp 415-417.

Timko, M. P., Ehlers, J. D. and Robert, D. A. (2007). Cowpea genome mapping and molecular breeding in plants Vol. 3. In: Pulses, Sugar and Tuber Crops. Kole, C. (Ed). Springer-Verlag Berlin. Pp 49-67.



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