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Seed-Borne Diseases and Nigeria Agriculture

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Abstract: The most important prerequisite for good crop production is the availability of good quality seeds of high yielding v--arieties, disease free, adapted to the growing area, and preferred by the farmer. Seed-borne disease refers to the particular plant diseases that are transmitted by seed. Seeds are the most important and cheapest input in crop production as 50 % gain in productivity is attributable to use of improved seeds. The quality of seeds alone is known to account for an increase in productivity of at least 10–15 %. To achieve this high quality, all the factors in production that will affect seed viability, disease free and genetic purity should be taken into account. "Seed quality" can have different meanings, depending on whether the seed is being characterized for sale into the marketplace for feed/food use, or for use as seed to plant. For example, marketplace quality characteristics include colour, shape, size, uniformity, and freedom from debris while planting seed quality include all the above and pest/disease free. Planting seed that is free of seed-borne pathogens is the primary means of limiting the introduction of pathogens, especially new pathogens, into a field. Planting infected seed may also result in widespread distribution of disease within the crop, and allows for an increased number of initial infection sites early from which the disease can spread. Most farmers in Nigeria plant uncertified seed saved from the previous harvest, borrowed from neighbors or purchased from local markets, factors that encourage spread and introduction of new diseases. The success of modern agriculture depends on pathogen free seed with high yielding character and in turn disease management. Infested seeds are responsible for the re-emergence of diseases of the past, movement of pathogens across international borders, or the introduction of diseases into new areas. Considerable attention has been paid to improving the sensitivity and selectivity of seed health assays by using techniques such as flow cytometry and the polymerase chain reaction which are of course not easily accessible by resource-poor peasant farmers.. This article focus on the importance, management challenges and the suggested way forward of seed-borne diseases management in Nigeria agriculture.
Keywords: crop, Seeds, plant diseases, Nigeria

INTRODUCTION

Agro-Ecological zones in Nigeria

Nigeria extends from latitude 04.03 ^{0}N to 14.00 ^{0} N and from 02.05 ^{0} E to nearly 15.00 ^{0} E. [1]. Annual rain fall ranges from 2500 mm in the south east tip of the country to 500 mm in the north. The rainfall gradient as well as with physical and other climatic factors have resulted in the formation of parallel vegetation across the country from the mangrove swamps in the areas of the south through the rain forest, forest savannah, Guinea savannah to Sudan savannah in the most northern parts of the country. Types of crop and production systems vary from one major ecological zone to the other [2]. The population of Nigeria is currently estimated at over 160 million people and more than 70 % are engaged in subsistence agriculture. The total land area is about 913.076 km^2 while the arable land available is less than 40 % of the total land mass. Effort to increase crop production to ensure food security for the ever growing population has altered the balance of nature (i.e. changing the existing ecological checks and balances and maintaining control. The alteration of the ecosystem gave rise to astronomical increases in insect pests, diseases and weeds on the farm land [3]. These pests are the most limiting factor in food production security in Nigeria, apart from drought. Increasing crop productivity through use of high yielding cultivars and avoiding crop failure are the two ways of boosting food production. One of the most pressing problems facing Nigeria and indeed the third world is food scarcity. It is reported that nearly 1 billion people are challenged by severe hunger in Nigeria and other third world put together, of which 10 % actually die from hunger-related complications. A substantial part of this hunger problem stems from inadequate management of seed-borne diseases that cause diseases either on the fields or induces spoilages on store produce [4,5]. Seeds provide an efficient inadvertent means in disseminating plant diseases. The diseases could be of plant, man or animal carried in/on plant seeds [6]. We all know that seeds are the foundation of agriculture and the most important input to ensure good production. Good quality seeds should meet the following characteristics:

- Genetic purity and uniformity and conform to the standards of the particular cultivar.

- Seeds are disease-free, viable, free from admixtures of seeds of other crops and weeds and inert material.
- Seeds are uniform in size, shape, and colour.

Benefits of using high yielding cultivars may be nullified by dangerous seed-borne diseases However, the Nigerian seed industry is still developing and until such a time that it is well developed, seed production at the community level, by government agencies, and from farmers' savings will still be very important for agricultural productivity. Infected Seed with microorganism are responsible for some of the most severe crop loss in the world today. Seed production technology has made tremendous advances against such loss in recent years but losses still occur, particularly in developing and under developed tropical countries [7], depending on the crop species, management practices, and ecological factors [8-10]. Not much is known about the impact of seed-borne diseases on the yield and quality of crops grown in Nigeria. A careful scrutiny of the published literatures on plant pathology shows that very little work is being undertaken by researchers on seed-borne pathogens [11]. Even the plant pathology curriculum designed and used in under-graduate and graduate student teaching does not cover aspects of seed pathology. This article focus on the importance, management challenges and the suggested way forward of seed-borne diseases management in Nigeria agriculture.

Importance of Seed-borne Diseases

Many microorganisms in the natural environment exist in multi-cellular aggregates described as biofilm association with solid surface like seeds. The surface properties of the plant tissues, nutrient and water availability and the species of the colonizing pathogens strongly influence the resulting biofilm structure [12]. Seeds are regarded as a highly effective means for transporting plant pathogens over a long distance. Numerous examples exist in agricultural literatures for the international spread of plant disease as a result of the importation of seeds that were infected or contaminated with pathogens [13,8]. Since the 1900s, consumer demand for new plant products gave opportunity for many plant pathogens to disseminate to new areas on imported seeds. Some seed-borne pathogens induces rots on produce which reduce the market value of affected produce, hamper the addition of value to them and prevent produce to complete their roles in the food chain. In a bid to keep these organisms at bay, controls are employed which increase the cost of production. These costs are passed over to the end users of the commodities. Another very important impact of seed-borne pathogens is production of various types of mycotoxins on produce such as oil seeds, maize and cereals. Mycotoxins are toxic, low molecular weight, secondary metabolites produce some species of fungi. They are dangerous in minute quantities and present extreme toxicity due to their ability to withstand heat [14,15]. The mycotoxins of most agricultural importance are aflatoxins, fumonisins, ochratoxin, zearalenone and deoxynivanelol [15]. Fungal toxin contamination of food products can cause acute or chronic intoxications, leads to reduced life expectancy; exacerbate disease conditions in humans consequently,leading to about 40 % loss of economic productivity. Mycotoxins are carcinogenic, cytotoxic, hepatotoxic, nephrotoxic and teratotoxic. New markets for plant commodities encouraged plant breeders to begin collecting seed stocks from abroad. The births of new seed companies extend their markets to new area [16]. Most of these seed borne pathogens could have severe economic and ecological consequences if they are introduced and become established in regions where they are not native. A pathogen may penetrate parts of the seed and in turn infect them. The infestation/ contamination of the seed may occur during harvesting, threshing and processing. The pathogen may thus, be carried with the seeds in three ways:

i. Admixture: pathogens are independent of seeds but accompany them. *Ergot sclerotia* are mixed with healthy seeds during threshing.
ii. External: the pathogen may be present on seed surface.
iii. Internal: pathogens establish within the seed with definite relationship with seed parts.

Status of Seed-borne Pathogens in Nigeria Agriculture

The reasons for the under-estimation and poor understanding of the importance of seed-borne pathogens are numerous. These may be due to inadequately trained personnel, lack of research facilities, and paucity of experimental evidence to show the effect of seed-borne pathogens on crop yield and quality in Nigeria. The seed-borne pathogens could remain viable for long periods if the seeds were kept under good storage conditions until planting time. These pathogens may cause failure of the seeds to germinate or may infect the germinating seedlings and the mature plants in future.

Most farmers in Nigeria still keep planting material, including seeds from one cropping season to another thus caring a potential source of inoculum detrimental to crop production [18]. This practice, no doubt, will continue in the foreseeable future. In addition, some seeds uses in Nigeria agriculture are imported from foreign countries. Although such seed importations are frequently inspected for weed or insect pests by quarantine service, no such inspections are conducted or required for seed-borne pathogens. A testing and/or certification program for seed-borne pathogens is needed in Nigeria agriculture so as to prevent losses in some crops. Below are few examples of seed-borne diseases on some selected crops in Nigeria.

Table-1:Seed born Pathogen on Cereal crops in Nigeria

crop	Pathogen	Disease	**Source**
Maize	*Ustilago sp*	cob smut	[19]
	Fusarium sp	cob rot	,,
	Erwinia strewartii	bacterial wit	,,
	Colletotricum sp	antracnose	,,
	Aspergillus flavus	cob rot,,	[20]
	A. parasitica	Maize wilt	,,
	A. nominus		,,
		Smut	,,
Sorghum	*sphacelotheca spp*	Ergot	
	Clauviceps microcephala	seed rot	,,
	Colletotrichum sp	stalk rot//red leaf	,,
	Fusarium moniliforme		[20]
		ergot	
Millet		seedling blight	
	clauviceps fusiformis	green ear	[19]
	Drechslera sp	head smut	,,
	Sclerospora graminicola		,,
	Sphacelotheca sp		,,
Rice	*Fusarium sp*	Fusarium wilt	,,
	Aspergillus spp	Seed rot	,,
	Drechslera oryzae	,,	,,
	Bipolaris oryzae,	,,	,,

Table-3:Seed borne Pathogen on Horticultural crops in Nigeria

Crop	Pathogen	Disease	Source
Tomato	*Alternaria solani*	Early blight	[20]
	Fusarium sp	Wilt	,,
	Phytophtora sp	Late blight	,,
	Corynobacterilum sp	Bacterial canker	,,
	Tobacco mosaic virus	Mosaic	,,
		Purple blotch	,,
Onion	*Xanthamonas sp*		
		Black rot	
Cabbage	*Alternaria sp*	Black spot	,,
	Sclerotia sp	Watery soft rot	[21]
Pepper	*Erwinia carotovora*	Wilt, fruit rot	[22]

Effect of Seed-borne Pathogens on Agriculture

The seed borne pathogen may result in:

(I) Loss of germination

(II) discoloration and shriveling (III) development in plant diseases (IV) toxin production in infected seeds [13,8,17].

Some seed-borne pathogens produce metabolites which affects seed metabolism at the cellular level. Aflatoxins and the mycotoxins affect seed viability, germination, and vigor which ultimately affect seed yield [19]. The adverse effects of seed-borne mycotoxin, the ergot alkaloids, have been known for centuries on both man and animals, and out breaks of ergotism in human still occur in some developing countries [32,19]. Further, aflatoxin may act as a co-factor with hepatitis B virus, one of the main risk factors. Although an astonishing amount of scientific data on mycotoxin has been published within the last three decades, the bulk deals with laboratory experiments and surveys of foodstuffs, whereas data required for evaluation of the health implication in man, farm animals and overall productivity of farmers are sparse [33, 34]. In the last decades, multiple outbreaks linked to raw seed sprouts have occurred in countries throughout the world [35]. Seed sprouts have been implicated as vehicles of transmission in out breaks of food borne illness. Soy, mustard and cress sprouts submitted by a patient with gastrointestinal illness were found to contain large numbers of aerobic spore--forming bacteria. Bacteriologic examination of seeds in previously unopened sprouting kits revealed that the soy seeds were contaminated with *Bacillus cereus* in pure culture, while the mustard and cress seeds had *B. cereus* as a minor part of their flora. After germination, all the sprouts were contaminated with the pathogen

[34,12]. In 1988, raw mung bean sprouts were implicated in an epidemiologic study as the cause of an outbreak of Salmonella in Saint Paul infection in the United Kingdom. In Finland, eight sprout-borne Salmonella outbreaks occurred from 1980-1997 [34]. In 1994, two large outbreaks of Salmonellosis were linked to alfalfa sprouts (282 cases in Sweden and 210 cases in Finland. Both outbreak was caused by *Salmonella*, the implicated seeds were grown from Australian alfalfa seeds. In 1995, a large international outbreak of *S. stanley* infections in Finland and 17 states in the United States was caused by alfalfa sprouts grown from contaminated seeds suggesting the seeds were contaminated at some point during growing, harvesting or processing [35].Yet vital statistics from hospitals and records from veterinary diagnostic laboratories rarely include the entity mycotoxin induced diseases or seed transmitted human diseases in Nigeria. Established seed-borne pathogen may perpetuate and cause permanent depreciation of yields or may initiate devastating epidemics [12]

Table 4: Seed borne Pathogen on Legumes and/Oil crops in Nigeria

Crop	Pathogen	Disease	Source
Cowpea	*Xanthamonas sp*	Bacterial blight	[23]
	Cowpea yellow mosaic virus	Mosaic virus disease	[20]
	Colletotrichum sp	Anthracnose leaf blight	[23]
	Cercospora cruenta	leaf blight	,,
	Sphaceloma sp	Scab	,,
Soybean	*Xanthamonas sp*	Bacterial pustule scab	[24]
	Pseudomonas sp	Bacterial blight	[23]
	Sclerotinia sp	Stem rot	,,
	Cercospora soyina	Frog eye leaf spot	,,
	Soybean mosaic virus	Mosaic	,,
	Colletotrichum sp	Anthracnose	[19]
			,,
Cotton	*colletotrichum sp*	Seedling blight / boll rot	,,
	verticillium sp	Wilt	[19]
	Xanthamonas sp	Angular/leaf spot	[25]
	Rhizoctonia solani	Damping off	,,
	Sclerotia sp	white rot/ stem rot	,,
			,,
Sun flower	*verticillium sp*	Wilt	
	Alternaria sp	seedling rot, stem rot	[19]
			[25]
Sesame	*Cercospora sp*	Brown leaf spot	,,
	Fusarium spp	Wilt	[24]
	Macrophomina sp	Charcoal rot, stem rot	
	Xanthamonas sesami	Bacterial leaf spot	
Melon	*Fusarium spp*	Wilt	[6]
	Rhizopus spp	Mould	,,
	Aspergillus spp	Seed rot	,,
	Trichoderma sp	Damping-off	,,
	Curvularia sp	,,	
Groundnut		Mouldy seed	[26]
	Penicillium spp	Yellow rot	,,
	Aspergillus flavus	Damping-off	,,
	Pythium spp	Charcoal rot	,,
	Macrophomina phaseolina	,,	[27]
	Aspergillus niger		

Table -5: Postharvest rot and spoilage organisms of tubers in Nigeria

Crop	Pathogen	Source
Yam (*Discorea* spp.)	*Rhizoctonia solani*	[19]
	Sclerotium rolfsii	,,
	Mucor spp.	,,
	Circinelloides spp.	[28]
	Rhizopus stolonifer	,,
	Aspergillus spp	,,
	Fusarium spp	,,
	Penicillium spp	,,
	Macrophomina phaseolina	[19]
	Rhizopus nodorus	,,
	Aspergillus flavus	
Cassava *(Manihot sp.)*		
	Fusarium solani	[28]
	F. oxysporium	,,
	Candida spp.	,,
	Aspergillus spp	[19]
Cocoyam	*Mucor* spp.	,,
Sweet potato (*Ipomea sp.)*	*Penicillium oxalicum*	[28]
	P. digitatum	,,
	Trichoderma viride	,,
	Rhizopus stolonifer	[19]
	Aspergillus spp	[28]
	Fusarium spp	,,
	Rhizoctonia solani	,,
	Mucor spp.	[19]
Irish potato	*Rhizopus oryzae*	[29]
	Fusarium redolens	,,
	F. oxysporium	,,
	Penicillium sp.	,,
	Alternaria solani	,,
	Rhizogospora spp.	,,
	Heminsthoporium solani	,,
	Colletotrichum atramentarium	[31]
	Aspergillus niger	,,
	Pythium ultimum	,,
	Phytophtora infestans	[31]
	P. parasitica	,,
	Rastoma solanacearium	[22]
	Verticillium sp.	,,
	Erwinia carotovora	,,

Management Challenges of Seed-borne Pathogens

Control of seedling diseases is a major priority in many cropping system. Seed treatment that induces systemic resistance after seedling emergence may be an ideal way to provides protection against diseases during the establishment of the crop [36]. In practice seed-borne pathogens could be manage/control through seed testing, quarantine and treatment. Certified seed is checked for the presence of certain seed-borne diseases. The detection of seed-borne pathogens and seed diseases is an important aspect of disease management [37]. Determining the presence of seed-borne pathogens allows farmers to apply the appropriate controls or modify management practices to avoid the problem in the future. The presence of diseased seeds in seed lot cannot be reliably detected by visual examination. The various methods are direct plating of seeds in a suitable media, seed washing assay, seed destruction assay, radiographic method, and recently the use of Enzyme Link Immunosorbent Assay (ELISA) and polymerase Chain Reaction (PCR) have been developed to detect pathogens in seed lots [38,39]. A radiographic assay of seeds provides an efficient, non destructive method of seed testing. Radiographic, ELISA -and PCR assay are highly specific, less time consuming, and affords greater accuracy because sample size can be greatly increased [39].

What is a Seed Treatment?

Seed treatment is a term that describes both products and processes. The usages of specific products and specific technologies can provide the suitable growth environment for seed, seedlings and growing plants. Seed-borne disease-causing pathogens may occur on the surface of seed, hidden in cracks or crevices of seed, or as infections deep inside the intact seed. These pathogens may be important for three reasons. First, some pathogens do not survive in soil or crop residue and are dependent on the seed-borne phase for survival between crops. An example is the fungus that causes loose smut of wheat. Second, even if a pathogen can survive in soil or residue, being seed-borne may allow it to get a head start and, thus, result in more severe disease. An example would be the fungus that causes Septoria leaf blotch of wheat. Third, seed-borne pathogens may hitch a ride to new localities in seed shipments (such as the fungus that causes Karnel bunt of wheat or the bacterium that causes black rot of crucifers).

For the purposes of this work, seed treatments are defined as chemical or biological substances that are applied to seeds or vegetative propagation materials to control disease organisms, insects, or other pests. Seed treatment pesticides include bactericides, fungicides, and insecticides. Most seed treatments are applied to true seeds, such as corn, wheat, or soybean, which have a seed coat surrounding an embryo. However, some seed treatments can be applied to vegetative propagation materials, such as bulbs, corms, or tubers (such as potato seed pieces).

What is not a Seed Treatment

Seed-applied growth regulators, micronutrients, and nitrogen-fixing Rhizobium and Bradyrhizobiuminoculants are not included because they are not intended for pest control. Treatments designed to protect stored food or feed grain are considered grain treatments rather than seed treatments. Pest control in stored grain and storage facilities requires additional licensing to forestall accidental food poisoning by unsuspected consumers.

Benefits and Risks of seed treatments

Seed treatments are used on many crops to control a variety of pests. Seed treatments are commonly used to ensure uniform stand establishment by protecting against soil-borne pathogens and insects. In fact, they are considered so essential for corn stand establishment that virtually all corn seed is treated. Seed treatments have had phenomenal success in eradicating seed-borne pathogens, such as smut or bunt, from wheat, barley, and oats. Seed treatments can be used to suppress root rots in certain crops. Finally, some newer systemic seed treatments can supplement or may provide an alternative to traditional broadcast sprays of foliar fungicides or insecticides for certain early-season foliar diseases and insects. Although seed treatments have important benefits, they also pose certain risks. One risk is accidental exposure of workers who produce or apply seed treatments. Another risk is contamination of the food supply by accidental mixing of treated seed with food/grains

Advantages of Seed Treatment

Seed-borne pathogens are vulnerable; the seed-borne phase is often the weak link in the lifecycle for many plant pathogens. Using seed treatments to control seed-borne pathogens is often very effective for disease control and precision targeting. Seed treatments are not subject to spray drift. Because chemicals are applied directly to seeds, little is wasted on non target sites, and ensures optimum timing. Seeds and seedlings are generally more vulnerable to diseases and insects than mature plants. Applying treatments to seeds allows pesticides to be present when needed most and at the right dose. Relatively small amounts of pesticides are used in seed treatments compared to broadcast sprays. This reduces the cost and the potential environmental impact. It also reduces the probability of chemical residues in harvested grain. Seed treatments are relatively easy and cheap to apply compared to broadcast sprays.

Disadvantages of Seed Treatments

Accidental poisoning: Treated seed looks like food to some animals. Hungry livestock that find carelessly handled treated seed will probably eat it. Birds, such as pheasants or quail, may consume spilled treated seed. Even young children may find and eat improperly stored treated seed.

Cropping restrictions: Just like other pesticides, some seed treatments may have significant grazing or rotation crop restrictions.

Limited dose capacity: The amount of pesticide that can be applied is limited by how much will actually stick to the seed. Seed coating technologies are helping to overcome this limitation, but phytotoxicity may still be a problem.

Limited duration of protection: The duration of protection is often short due to the relatively small amount of chemical applied to the seed, dilution of the chemical as the plant grows, and breakdown of the chemical Limited shelf life of treated seed. Producing excess treated seed is undesirable because the shelf life of treated seed may be limited. Surplus treated seed cannot be sold for grain. This is a particularly serious limitation for seeds such as soybean, where seed germination and vigor decline relatively quickly.

Phytotoxicity. Pesticide injury to plant tissues is called phytotoxicity. Since seed treatments must exist in high concentrations on the tender tissues of germinating seeds and seedlings, they generally have very low phytotoxicity. A few seed treatments are partly phytotoxic when applied at high rates.

Lower germination and/or stunting may occur if application rates are not carefully controlled. Cracked, sprouted, and scuffed seeds may be particularly susceptible to toxic effects. A few seed treatments may reduce the length of the sprout and, therefore, affect the choice of planting depth. Worker exposure: In the course of treating and handling large volumes of seed, workers may be exposed to seed treatment chemicals as aerosols. Inhalation of aerosols and skin contact with seed treatments must be prevented in the seed treatment process.

Types of Seed Treatment:

- Seed disinfection: Seed disinfection refers to the eradication of fungal spores/pathogen cells that have become established within the seed coat, or in more deep-seated tissues. For effective control, the fungicidal treatment must actually penetrate the seed in order to kill the fungus/pathogen that is present.
- Seed dis-infestation: Seed dis-infestation refers to the destruction of surface-borne organisms that have contaminated the seed surface but not infected the seed surface. Chemical dips, soaks, fungicides applied as dust, slurry or liquid have been found successful.
- Seed Protection: The purpose of seed protection is to protect the seed and young seedling from organisms in the soil which might otherwise cause decay of the seed before germination.

Conditions under which seed must be treated

- Injured Seeds: Any break in the seed coat of a seed affords an excellent opportunity for disease pathogens to enter the seed and either kills it, or weaken the seedling that will be produced from it. Seeds suffer mechanical injury during combining and threshing operations, or from being dropped from excessive heights. They may also be injured by weather or improper storage.
- Diseased seed: Seed may be infected by disease organisms even at the time of harvest, or may become infected during processing, if processed on contaminated machinery or if stored in contaminated containers or warehouses.3) Undesirable soil conditions: Seeds are sometimes planted under unfavorable soil conditions such as cold and damp soils, or extremely dry soils. Such unfavorable soil conditions may be favorable to the growth and development of certain fungi spores enabling them to attack and damage the seeds.4) Disease-free seed: Seeds are invariably infected, by disease organisms ranging from no economic consequence to severe economic consequences. Seed treatment provides a good insurance against diseases, soil-borne organisms and thus affords protection to weak seeds enabling them to germinate and produce seedlings.

Equipment Used for Seed Treatment

Equipment uses to treat seed are categorized into two major groups. Commercial seed treater and included the following; market-dust treater, slurry treater, and direct treater. The commercial seed treaters are designed to apply accurately measured quantities of pesticides to a given weight of seed. The local seed treaters includes home- made drum mixer, grain auger and shovels. The commercial seed treaters are not common in Nigeria and farmers are left with no choice other than the use of local seed treaters. The local seed treaters have the problem of incorrect dosage rate; apply too much or too little material can be as damaging as never treating at all. Also the local seed treaters have the problem of uneven distribution of the active ingredients on the seed samples. This becomes more important for pesticides with contact activity than the systemic pesticides. All these affect the effective control of seed-borne pathogens using seed treatment method in Nigeria.

Seed Treatment Chemicals

Several specific chemicals were developed to control specific pest problems. These includes fungicides for fungi, bactericides for bacteria, nematicides for nematodes, insecticides for insects, avicides for birds, vermicides for vermine, and herbicides for herbs. However, in Nigeria and indeed most African countries use fungicides seed treatment products more compared to other pesticides chemicals [39]. Similarly, reported that most seed treatment products are fungicides or insecticides applied to seed before planting. Most fungicides seed treatment do not control bacterial pathogens and most will not control all types of fungal diseases [40,41]. So it is important to carefully choose the seed treatment that provides the best control of the disease organisms on the seed or potentially present in soil. The degree of control will vary with product, rate, environmental conditions and disease organisms present [40,2]. This erroneous believe that fungicide chemicals can control all other seed-borne pathogens contributes to the recalcitrant nature of seed-borne diseases. Most of the problems of farmers also lie in the product choice and dosage applied. For example, a famer was seen using cocoacide (fungicides) to control cotton bollworm-allegedly with failure [2]. Lack of money causes farmers to employ a product they have purchased for use on every conceivable disease and pest. The products are usually labeled in English, and most farmers are illiterates. In all, the level of education, sex, farm size, and age of farmers affect the use seed treatment chemicals [42].

Mode of Action of Seed Treatment Chemicals

In general, seed treatment chemicals may have either systemic or contact modes of action. Controlling pathogens that are carried within the seeds require a systemic seed treatment product, whereas contacts are adequate for surface-borne pathogens. Seed treatment that induces systemic resistance after seedling emergence may be an ideal way to provide protection

against disease during the establishment of the crop [36]. Also seed treatment chemicals could be specific and non specific in actions. Most of the non selective commercial fungicides interfere with several metabolic process in the fungal cell, hence are called multisite inhibitors. On the contrary, selective fungicides are site specific. Even a single gene mutation may result in the development of resistance strains against a specific fungicide. Thus, the resistance problem is far more common and severe in selective fungicides compared to non selective one [43]. All systemic fungicides have some risk for the development of resistance by pathogens, but certain groups of fungicides are more at risk than the others. Currently available contact fungicides have essentially no risk of resistance [37]. Since bacteria are usually attached to seeds surfaces via biofilm formation, and biofilm are notoriously resistance to washing and other common antimicrobial treatments, more work on seed treatment is required.

The Non- chemical Seed Treatment

The non chemical seed treatments are; Biological seed treatment and bio-based seed treatments. Biological seed treatments are the use of antagonistic fungi and bacteria to protect seeds. Examples of these biological agents are *Trichoderma* sp. (antagonist fungus) and *Bacillus subtilis* (a bacterium). Biological seed treatments multiply in the soil, protecting root systems against soil-borne pathogens (i.e.: damping-off) after germination [44].

Bio-based seed treatments are made up of renewable resources and contain natural active ingredients. These seed treatments do not have any negative impact on the environment, workers, and consumer safety compared to chemical seed treatments and are expected to be one of the fastest growing seed treatment segment in the near future [45,46]. The science behind these technologies is not yet common to farmers in Nigeria, if there is; it is at the experimental level in the hands of scientists.

Way Forward

Carrying into effect, a well implemented quarantine inspection service for import as well as export, including strict post-entry quarantine provision. Testing seed for quarantine calls for still more criticism than testing seed for disease already established within the country. To avoid the risk of introductions that may be particularly detrimental to import crops, the seed must be grown to maturity under strictly controlled environment. From absolutely disease-free plants, the seed should be harvested and a sample of it thoroughly tested for presence of infections before the seed thus produced should be released. There should be regular training of seed pathology and other technical staff as well as massive enlightenment of farmers and other stake holders on importance of planting certified seed. Seed certification and seed production must go hand in hand. Proper seed processing must be part of the schemes leading to issuance of certified seed. As a consequence, the three main phases in technical procedure will be (i) field inspection of seed crops (ii) processing of the harvested seed and (iii) laboratory test. A field inspection schemes is of importance as a basic safeguard enabling rejection of seed crops that show conspicuous symptoms but it may not warrant against symptomless carriers of the pathogens. An adequately conducted laboratory seed health test yields reproducible results and is a reflection of actual health condition of a given seed lot. Chemical formulations are non existence in Nigeria, all chemical companies found in Nigeria are marketing outlets of the main companies overseas [3]. This means that seed treatments chemicals are imported into the country for local consumption which might not suit the prevailing climatic conditions in the country. Centralizing government regulation for treated seed and seed treatment active ingredient registration is expected to address the local needs of the farmers. Key factors to be considered in registration of active ingredients are grower friendly, crop-friendly, and environmental-friendly among other things. Localization of such companies should be based on different ecological zones of the country. The use of seed treatment chemicals without due regard to the conditions prevailing as well as annual cropping patterns in different ecological zones of the country encourages out-break of pests and diseases. The risk of seed-borne diseases infection varies widely by crop, disease and location. Much disease will only become a problem if grown in a region or environment conducive for the disease. Regional advantages should be exploited in management of seed-borne pathogens. Seed production should be in an area where the climatic conditions do not favor the growth multiplication of diseases. For example, in United States, seed production occurs primarily in the Western states where dry summer aid in minimizing disease pressure [11]. The poor application technology and techniques causing in-effective coverage of seeds and exposure of worker may be addressed by providing commercial seed treaters. Economic importance of seed-borne pathogens should be carried out on some crops of major importance to enable the farmers appreciate the importance of seed-borne pathogens. However, the importance of seed-borne diseases has been determined in a few cases. Increase research and training of man power in the area of seed pathology will no doubt boost the availability and distribution of healthy seed which is the most factors in improving crop production for the small-scale and subsistence level farmers. Well equipped laboratories should be built in all the ecological regions of the country for testing seed samples, recommend, and evaluation of efficacy of seed treatment chemicals. It is recommended to have a seed tested at an accredited laboratory to assess the level of seed infections.

CONCLUSION

The production of high quality seeds necessitates a high level of management that covers the

period from planting to the delivery of seeds to the growers. Seed growers should plan all farm operations well in advance to ensure the seed crop has the highest priority. Lastly, agronomic practices (disease management and maturity at harvest) should be applied properly in seed fields. In summary, this paper emphasizes the following issues in relation to seed-borne diseases and the ways and means available to reduce their role in crop losses. They are (i) Effect of seed-borne pathogens on Agriculture (ii) educating researchers, extension workers, and farmers on what and what not is/are seed treatments and the importance of disease –free seeds and planting material for crop production, (ii) challenges of seed-borne management and (iii) the way forward in the management of seed-borne diseases in Nigeria. One of the critical success factors in the management of seed-borne diseases will be the ability of the scientists to innovate complete protection against various biotic stresses in a single product since it is a common observation that two or more diseases appear at the same time on the seed. Let me say that the only justification for this article is the transfer of many points discussed here downstream to the farmers' field and the final outcome of such should be the increase of agricultural production in the country and beyond.

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