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A Review on Management of Seed Borne Diseases through Seed Multiplication Strategies

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ABSTRACT: The most of plant diseases are spread through seeds, which is a serious obstacle to obtain high-quality seeds and higher yield. A tiny embryonic plant called a seed is an effective way to spread plant pathogens to new areas and gives them a way to survive from one growing season to the next. One of the most significant biotic constraints on seed production globally is the presence of seed-borne fungi. It is crucial to maintain the initial infection of seed because it serves as a vehicle for the dispersal and survival of plant pathogens. In this connection a review on many seed multiplication strategies for challenging the maintenance of seed borne diseases have been studied which can give proper information to the farmers, seed growers and seed company whose are involved in seed multiplication programme. The major strategies like Selection of disease free field area, source of seed, seed treatment, sowing practices, rouging, isolation requirement, biological control, chemical control, proper harvesting etc. provide a basis for improving seed as an essential part of seed multiplication. The goal of this review is to educate farmers and seed growers with some significant seed pathogens and management strategies for diseases spread through seeds. As a result, seed growers or farmers can obtain maximum seed yield with better quality by using disease free seed in future.

Keywords: Seed borne disease, Seed source, Isolation, Physical treatment, Biological control, Chemical control.

INTRODUCTION

Seed is still the most important input in agricultural productivity. Around 90% of all food crops are grown on the world, and seed is used to propagate these crops. Seed is the most commonly purchased agricultural product (Khetrapal, 2004). Seed quality encompasses genetic quality, physical quality, physiological quality, and status of seed health (Louwaars, 2007). Since the world population is predicted to increase to over nine billion people by the year 2050, seed quality has become more important than ever for ensuring sufficient food security (Sabry, 2018). A minimum seed certification standard is maintained during field inspection for the multiplication of quality seed against the specified seed borne diseases. A seed is not allowed to be sold as a quality seed if it fails to meet minimum seed certification criteria during field inspection. Seeds are likely to include a range of microorganisms after harvesting, with fungus and bacteria playing a key role in the deterioration of various agricultural seeds. Diseases like bacteria, fungi, or viruses that survive on the surface or inside of seeds and have the potential to infect the coming crop are known to as seed borne diseases. All of the seed borne diseases, fungal contamination is more serious (Colley, 2009). Field fungi and storage fungi are the two categories of seed-borne fungi (Christensen and Kaufmann,1965). Field fungi are inactive during storage because they cannot grow in dry circumstances, whereas storage fungi may thrive in dry environments. *Clasporium cladosporioides*, *Alternaria alternaria*, *Verticillium lecanii*, *Epicoccum purpurascens*, *Fusarium* species, *Helmintho sporium*, *Penicillium* species, and *Aspergillus flavous* are common species of field fungi invading cereal grain (Amare *et al.*, 1995). Several studies have documented that storage fungi have attacked and killed several crop plants, including pigeon pea (*Arachis hypogaea* L.) (Diener, 1958), cotton (*Gossypium hirsutum* L) (Arndt, 1946), andpeas (*Pisum sativum* L. Subsp. Sativum) (Fields and King 1962). *Aspergillus* and *Penicillium* species are seed storage fungus. *Aspergillus niger* and *Aspergillus flavus* were found in abundance in peanuts (Nandi and Haggblom 1984; Sinha and Sinha 1990). Mycotoxins are compounds that cause a reduction of grain quality, poor germination capacity, and reduced vigour. They are produced by specific seed-borne fungal infections (Agrios, 2005). Groundnut seeds are also excellent substrates for Aspergillus flavus aflatoxin synthesis (Muralimohon and Reddy 1995). Hussain *et al*. (2013) found a number of mycotoxins created by Aspergillus species, including aflatoxins and sterigmatocystin. Kulik and Schoen, 1977 reported that treated seeds with a chemical fungicide or bactericide, one or more of the foregoing fungal or bacterial diseases can arise. Several chemical pesticides used as seed treatments and field spraying for pest control in high yielding and hybrid cultivars of various crops are no longer effective, and high yielding, hybrid cultivars are also prone to several diseases. Infected seed has been found to be a primary source of inoculums for a variety of diseases affecting many important cereal and fibre crops (Neegaard, 1977). Several biological control agents can suppress diseases as effectively as fungicides, an input that is often prohibitively expensive to be of value to resource-poor farmers (Srivastava, 2017).

Seed-borne infections have been shown to have a particularly negative impact on the germination, growth, and production of several crop plants (Kumar and Gupta 2020). Proper seed treatment is vital for seed quality improvement and significant increase in crop yield (Akpor and Obeasor 2019). Disease attack may differ depending on production areas, varietals, and climatic conditions. As a result, the current review study is critical for implementing seed multiplication strategiesin order to eliminate seed-borne diseases. It may involve disease-free field area selection, sanitation, condition of soil, tillage operation, sowing practices, irrigation, isolation requirement, fertilizers, rouging, Physical seed treatment, biological control, chemical control, and so on.

Selection of disease free field area. Seasonal and regional disease-free zones aid in the development of high-quality seeds. It aids in maintaining seed health, genetic purity, and preventing infectious diseases from spreading from one location to another. Seed storage and protection against pathogens and viability losses are best achieved in dry and cool environments. Varietal susceptibility and adequate climatic circumstances for pathogen multiplication and disease incidence in different years at vulnerable stages of wheat growth have created variation in disease occurrence in disease endemic locations (Bedi and Dhiman 1982; Aujla *et al.*, 1986; Singh *et al.*, 1996; Sharma *et al*., 1998). Using the same site for seed multiplication of various crop plants year after year is likewise not suggested. Many fungal and bacterial diseases, such as karnel bunt of wheat, anthracnose of bean, late blight of potato, green ear and smut disease of pearlmillet, wilt of arhar, may appear for destroying field crops when grown on the same area year after year. In wet situations, sugarcane red rot, damping off, and root rot may emerge. By which a good drainage channel is required for controlling this type of diseases. Deep ploughing of soils can effectively suppress the late blight of potatoes (*Phytopthora infestans*). Volunteer plants and noxious weeds should be removed from designated areas because they serve as a reservoir for numerous seed-borne pathogens. The most of plant diseases are spread through seeds, which is a serious obstacle to obtain high-quality seeds and higher yield. A tiny embryonic plant called a seed is an effective way to spread plant pathogens to new areas and gives them a way to survive from one growing season to the next. One of the most significant biotic constraints on seed production globally is the presence of seed-borne fungi. It is crucial to maintain the initial infection of seed because it serves as a vehicle for the dispersal and survival of plant pathogens. In this connection a review on many seed multiplication strategies for maintaining seed borne diseases have been studied which can give proper information to the farmers, seed growers and seed company whose are involved in seed multiplication programme. The strategies provide a basis for improving seed as an essential part of seed multiplication. The goal of this review is to educate farmers and seed growers with some significant seed pathogens and management strategies for diseases spread through seeds.

Table 1: Seed Certification Standards for foundation and certified seed plots based on maximum percentage of seed borne disease.

Name of crops andtheir scientific name	Crops affected by seed borne diseasesand their causal organisms	Maximum permitted (%)*	
		Foundation	Certified
BARLEY (*Hordeum vulgare* L.)	Loose Smut (*Ustilago nuda* (Jens.) Rostr.)	0.10	0.50
BARLEY (*Hordeum vulgare* Linn.) HYBRIDS	Loose Smut (*Ustilago nuda* (Jens.) Rostr.)	0.10	0.50
WHEAT (*Triticum* spp.)	Loose Smut (*Ustilago tritici* (Pers.) Jens.)	0.10	0.50
COWPEA (*Vigna unguiculata* [L.] Walp.)syn. V. sinensis [L.]	Stem blight (*Macrophomina phaseoli*), Anthracnose (*Colletotrichum lindemuthianum*) Ascochyta blight (*Ascochyta* spp.)	0.10	0.20
GREEN GRAM (*Vigna radiata* (L.)Wilczek)	*Halo blight (Pseudomonas phasiolicola)*	0.10	0.20
INDIAN BEAN (Lab lab purpureus)	Bacterial blight (*Xanthomonas* spp.) Anthracnose (*Colletotrichum lindemuthianum*) Ascochyta blight (Ascochyta spp.)	0.10	0.20
RAJMASH (FRENCH BEAN) (*Phaseolus vulgaris* L.)	Bacterial blight (*Xanthomonas* spp.) Anthracnose (*Colletotrichum lindemuthianum*) Ascochyta blight (*Ascochyta phaseolorum* Bean mosaic (*Macrosiphum pisi* Kalt.)	0.10	0.20
SESAME (TIL) (*Sesamum indicum* L.	Leaf spot (*Cercospora sesame* Zimm.)	0.50	0.10
CABBAGE (*Brassica oleracea* L.) *capitata* L	Black leg (*Leptosphaeria maculans*) Block rot (*Xanthomonas campestris*) Soft rot (*Erwinia carotovora*)	0.10	0.50
CELERY (*Apium graveolens*)	Leaf blight (*Septoria apiicola*) Root rot (*Phoma apiicola*)	0.10	0.50
PARSLEY (*Petroselinum crispum*)	Leaf spot (*Septoria petroselini*)	0.10	0.50
CAULIFLOWER	Black leg (*Leptosphaeria maculans*)	0.10	0.50

Source : INDIAN MINIMUM SEED CERTIFICATION STANDARDS, Government of India New Delhi 2013

Sanitation. Crop residue destruction is a crucial management method for controlling numerous plant diseases between cropping seasons. By burying crop residues, diseases such as Sclerotium oryzae in paddy, X. Axnopodis pv. Phaseoli in cotton, and X. Campestris pv. malvacearum in rice can be eradicated. Deep ploughing is used to control bury waste and reduce the southern blight disease on peppers, tomatoes, and other plants.

Condition of soil. Different seed and soil borne diseases impede crop growth due to soil type and texture, aeration, acidity, and alkalinity, among other factors. Seedling disease can emerge in soilsthat are flooded. Covered smut disease in wheat is more common in areas with high soil moisture and low soil temperature. Dry soil, on the other hand, is ideal for sorghum headsmut disease (*Sphacelotheca relianum*). In this regard, adequate drainage and an appropriate pH are critical to ensuring optimal crop growth. Fungi that thrive in acidic soil, such as Cleviceps and Colletotrichum, for example. Bunt of paddy (T. Horrid) can occur in heavy soil. By mixing organic compost amendments into the soil, aeration is promoted and beneficial bacteria may be protected, and disease incidence is minimised (Kumar *et al.* 2010, 2017b).

Source of seed. Seed-borne diseases are able to infect the seed during seed multiplication, spread from seed to seedling during, and then attack the plant in main field that is after transplanting . Planting infected seeds might result in lower yields due to poor germination, higher seedling mortality, stunted growth, and plant diseases (Solorzano and Malvick 2011). Seeds should only be purchased from reputable sources. It indicates that for foundation seed multiplication, uses breeder seed and for certified seed multiplication, uses foundation seed. ICAR and State Agricultural University are authenticated sources of breeder seed; National Seed Corporation, State Seed Corporation, State Department of Agriculture, State Agricultural University, SFCI; and National Seed Corporation, State Seed Corporation, State Department of Agriculture, State Agricultural University, SFCI, Progressive companies, Govt. Farm, and others are authenticated sources of certified seed. Breeder seed is 100 percent pure genetically, foundation seed is 99.9% pure genetically, and certified seed is 98 percent pure genetically. Among the classes of seeds, farmers can grow only certified seed. The chances ofseed borne diseases and others associated diseases can be checked by growing the above classes of seeds.

Tillage operation. We should be cautious while tillage since some inoculums can be found in previous crop residues and surface soil. Some plant diseases have been widely distributed due to tillage operations in different varieties or crops in same land. In this connection, tillage should be cleaned for each and every tillage operation for controlling mechanical mixture. Because mixture is the most important factor for causing genetic deterioration as a result into unexpected lower crop yields.

Sowing practices. Changes in sowing timing, seed bed preparation, row spacing, sowing depth, and crop density are all factors that influence disease incidence. Disease incidence can be reduced by properly preparing the seed bed. Changes in planting time may take advantage of unfavourable weather circumstances for the pathogen and reduce crop losses. Black rot disease in crucifers can be avoided by planting them early. Early wheat and pea cultivars mature in a short periodof time, and these early maturing cultivars can prevent damage caused by *Puccinia graminis tritici* and *Erysiphe polygoni*.

Irrigation. When it comes to plant disease management, most types of irrigation are destructive rather than useful. Drought dessication of propagules is prevented by irrigation during dry seasons, resulting in an increase in inoculum levels. Excessive irrigation promotes karnal bunt infection; yet, frequent irrigation minimises the incidence of wheat flag smut. Low areas should be avoided, and measuring devices such as tensiometers can aid in irrigation management and thus best resource utilization, as well as disease management. (Montesano *et al.,* 2015).

Isolation requirements. To avoid specified seed borne diseases or other pathogens, natural crossing, and varietal admixture, proper isolation from fields of other cultivars of the same crop or cultivar should be maintained in the seed multiplication programme. Distance isolation, time isolation, and barrier isolation are the three strategies used to maintain isolation.

Table 2: Seed Certification Standards for foundation and certified seed plots based on isolation distance of seed borne disease.

Contaminants	Minimum isolation distance (meters)	
	Foundation Seed	Certified Seed
Loose smut of Barley disease in excess of 0.10% and 0.50% in Foundation and Certified seed	150	150
Loose smut of hybrid barley disease in excess of 0.10% and 0.50% in Foundation and Certifiedseed	200	150
Loose smut of wheat disease in excess of 0.10%and 0.50% in case of Foundation and Certified seed	150	150
Loose smut of hybrid wheat disease in excess of 0.10% and 0.50% in Foundation and Certifiedseed	200	150
Loose smut of oats in excess of 0.10% and 0.50% in Foundation and Certified seed	150	150

Source : INDIAN MINIMUM SEED CERTIFICATION STANDARDS, Government of India New Delhi 2013

Rouging. In a seed multiplication strategy, prompt rouging is essential. Before the seed crop flowers, disease-affected plants and unpleasant weed plants, off kinds, volunteer plants, and unwantedplants that are also disease pathogen reservoirs should be eliminated. Roguing can be done in most field crops at all crucial stages of development, including vegetative, pre-flowering, blooming, and maturity. Some key diseases that must be eradicated as soon as possible include those infected with loose and covered smut of barley, sorghum, and maize, as well as viral diseases such as yellow vein mosaic in okra and arhar wilt.

Fertilization. Plant density and fertiliser are obviously critical for good plant growth. Because dense foliage limits air flow and drying of leaf and stem surfaces, high nitrogen levels and dense spacing may increase disease susceptibility of host plants and resident pathogen populations. When nitrogen is applied judiciously for the construction of less dense plant canopies in order to ensure proper air circulation in the crop field, it can create unfavourable conditions for the growth of disease incidence (Dordas 2008).

Physical seed treatment. Physical seed treatment refers to using heat to eliminate seed borne diseases while causing the least amount of harm to the seed tissues. The following physical seed treatments are provided:

(i) **Hot water treatment.** Phoma betae was eradicated from sugarbeet seed by a hot water treatment at 500 C for 30 minutes, according to Lambat *et al*. (1974). Several bacterial diseases, such as bacterialblight of cluster bean (Xanthomonas campestris pv. cyamopsidis), have been advised for eradication using hot water treatment at 56°C for 10 minutes. Nega *et al*. (2003) found that a hot water treatment at 50°C for 30 minutes was successful in suppressing Xanthomonas campestris on carrot and cabbage. Hot water treatments of cabbage seeds have also been shown to be effective in controlling *A. brassicicola* and L. maculans. Specific water treatments at 50°C for 25–30 min and at 53°C for 10 min were shown to reduce *L. maculans* infections by 87–92%, and A. brassicicola infections by 92–99% respectively (Nega *et al*., 2003).

(ii) **Aerated steam treatment.** Aerated steam treatment can successfully reduce bacterial and fungal pathogen infection of bigger seeds without affecting seed germination and vigour. Pathogens on the outside of the seed as well as those inside the seed tissue can be killed using aerated steam treatment. (Navaratnarn *et al*., 1980; Darby *et al*., 2019). Septoria apiicola has been discovered to be completely eradicated in celery seed.

(iii) **Dry heat treatment.** Xanthomonas campestris pv. translucens of barley seeds should be treated with a dry heat treatment at 71-84°C for 11 days. Singh (1973) reported that a hot air treatment at 54°C for 8 hours effective for controlling red rot disease in sugarcane. Several bacterial and fungal diseases have been successfully eliminated from cassava seeds using microwave heating (Lozano *et al*., 1986).

Biological control. Overuse of chemical inputs can have a number of negative consequences, including disease resistance to the chemicals used and non-target environmental impact. There is a growing recognition that integrated pest management strategies can give more environmentally friendly and cost-effective options for managing seed-borne and soil-borne diseases (Spadaro and Gullino 2005). The needlessly frequent use of pesticides is increasingly creating worry in terms of human toxicity and dangerous consequences on the natural environment, therefore biological control has piqued interest in plant pathology. Fungi, bacteria, nematodes, viruses, and other microorganisms are examples of biocontrol agents. They reduce infections through microbial antagonistic activity, which is performed through parasitic infection, predators, competition, or mutualistic (Mukherjee 1983). Trichoderma, Aspergillus, Penicillium, Dactylella, and other key fungal species have been identified as potential biocontrol agents against several phytopathogens. Agrobacterium, azotobacillus, bacillus, erwinia, pseudomonas, rhizobium, streptomyces, and other bacteria have been used as biocontrol agents. For the treatment of rice blast pathogen, Gohel and Chauhan investigated the efficiency of fungicides, bio-agents (Pseudomonas flourescens), and botanicals (neem, tulshi leaves extracts). The use of antagonistic Pseudomonas fluorescens in biological seed treatments has been found to significantly reduce the incidence of bacterial wilt in chilli caused by Burkholderia solanacearum (Umesha *et al.,* 2005). There is some indication that microbial seed treatment preparations, such as Serenade® and FZB24®, both Bacillus subtilis-based products, are as effective as conventional fungicides at controlling anthracnose in bean crops (Tinivella *et al.*, 2009). Pre-harvest application of Bacillus subtilis prevents fumonisin development (Bacon *et al*., 2001). The use of antagonistic Pseudomonas fluorescens in biological seed treatments has been found to significantly reduce the incidence of bacterial wilt in chilli caused by Burkholderia solanacearum (Umesha *et al.,* 2005).

Chemical control. Systemic fungicides are more effective and can be used ahead of time (Rowell 1976). Propiconizole fungicide like tilt, is effective against rusts and other diseases in wheat, and the timing of administration is dependent on when the illness first appears (Watkins, 2004). Hossain and Mia (2001) found that two 0.1 percent foliar sprays of Aimcozim, Bavistin, Shincar, and Tilt, as well as two top dressings of MP at 40 kg/ha, significantly reduced tiller infection of sheath blight disease. Tilt was also shown to be the most effective fungicide for suppressing the illness. Chlorothalonil, mancozeb, mefenoxam, thiram, and azoxystrobin are the most popular fungicides administered to tomato seeds to prevent Fusarium wilt symptoms (Fravel *et al.*, 2005). Thiram and thiabendazole are also recommended as seed treatments to control Ascochyta spp. in faba bean and other grain legumes (Stoddard *et al.*, 2010). Systemic fungicides such as carboxin, carbendazim,propiconazole, raxil, and others have gained popularity as seed and foliar treatments for a number of different of devastating diseases such as loose smut of wheat, blast of paddy, downy mildew in bajra, seedling rot of sugar beet, head smut of maize, and others. Phytobacteria are best treated with antibiotics like streptomycin and tetracycline.

Table 3: List of some crop wise name of seed treatment chemicals.

Name of crops	Name of seed treatment chemicals	Doses of chemicals as seed treatment(gm)	Quantity of water in litre/ 100 kg of seed
Wheat	Thiram 75% WPD	100	0.500
Maize	Captan 75% WPD	70	0.500
Soyabean	Thiram 75% WPD	100	0.500
Sunflower	Thiram 75% dust	250	Dry dressing
Lentil	Thiram 75% dust	250	Dry dressing
Cotton	Captan 75% dust	250	Dry dressing
Jute	Captan 75% WPD	80	0.500
Pigeon peas	Thiram 75% WPD	75	0.500

Source : Principles & Practices of Agronomy by S.S. Singh, Kalyani Publishers, Reprinted,1999

Proper harvesting. One of the most critical factors in acquiring disease-free, high-quality seed is harvesting atthe right time. When at least 80% of the seed crop has ripened, the majority of it should be collected. Crops with a higher percentage of moisture during physiological maturity should be lowered until they reach maturity. In this case, if the seed is harvested before it is fully mature, it may become discoloured owing to fungal infection and lose vigour and viability during storage. One of the most common causes of seed deterioration during storage is mechanical injury. Mechanical damage to very dry seeds allows microflora entry and easy access, making the seed prone to fungal infection and limiting storage capability (Shelar, 2008). Small seeds are more susceptible to mechanical injury than large seeds. Postharvest disease management using mechanical processing is an essential and cost-effective new method for providing bunt-free wheat and paddy grain/seed.

CONCLUSION

Management of seed borne diseases through seed multiplication strategies like sanitation, condition of soil, tillage operation, sowing practices, irrigation, isolation requirement, fertilizers, rouging, Physical seed treatment, biological control, chemical control etc. are most important for obtaining good quality seed. Therefore, farmers, seed growers and seed companies whose are involved under seed multiplication programme should be aware and followed strictly the whole mentioned strategies for harvesting quality seed with maximum yield

FUTURE SCOPE

Maximum crop yield can be received by local farmer when he will apply the seed multiplication strategies in his own small land areas for obtaining quality seed at suitable sowing rime of crop cultivation those are discussed in this review studies.

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