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Sustainable Management of Seed Borne Plant Pathogens

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ABSTRACT

Productivity and sustainability in agriculture can be achieved either by increasing crop production through the use of high-yielding crop varieties or by avoiding crop failures mainly due to pests and pathogens. High-yielding cultivars are often susceptible to one or more pathogens. The basic need therefore is availability of good quality healthy seed/planting materials. Seeds are known to be carriers of a large number of microorganisms. Since about 90% of the crops are grown through seeds, they are also a potent source for dissemination of various diseases and survival of pathogens from season to season. Healthy seed can be obtained through appropriate certification schemes or by effective seed treatments, but it is difficult to restrict seed-transmitted diseases, which are also soil-borne, or perpetuate on plant residues. In order to reduce yield losses caused by diseases, farmers adopt calendar-based chemical spraying schedules rather than need-based sprayings, which lead to chemical residues in the produce and development of resistance in the pathogens and disturb the natural fauna. Losses due to plant diseases are expected to have more critical influence on human being in the coming years than they have had in bygone years. An integrated approach is needed for the effective control of the diseases and production and maintenance of pathogen-free seed in the field and during storage.

KEYWORDS: *seed borne, pathogens, management, sustainable, plant, field, spraying, chemical, diseases, storage*

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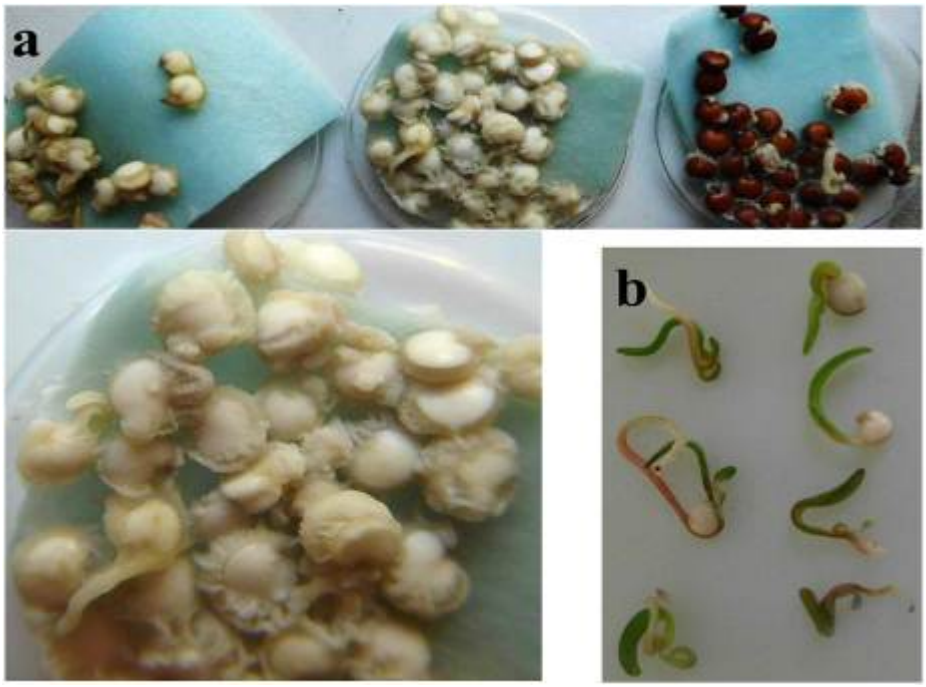
INTRODUCTION

Lettuce mosaic virus is an example of a disease in which the seed is the main source of the pathogen and if seed infection is controlled, the disease is prevented. Other seed-borne pathogens may start life as a foliar-borne or a soil-borne pathogen. Infected seeds will produce infected plants even in clean soil. Pathogens can infect the seed via several routes:[1,2] The parent plant can become infected by drawing soil pathogens through its roots up into the seed; Pathogenic spores can float in on the air (*Alternaria solani*, early blight of tomatoes; *Anthracnose* fungus that affects nightshades, watermelon and cucumber); Insects that feed on the plant can transfer the disease (striped cucumber beetles vector bacterial wilt, which is caused by *Erwinia tracheiphila*); Insects that pollinate the plant can bring infected pollen from diseased plants.

Vegetable crops are frequently infected by fungal pathogens, which can include seedborne fungi. In such cases, the pathogen is already present within or on the seed surface, and can thus cause seed rot and seedling damping-off. Treatment of vegetable seeds has been shown to prevent plant disease epidemics caused by seedborne fungal pathogens. Furthermore, seed treatments can be useful in reducing the amounts of pesticides required to manage a disease, because effective seed treatments can eliminate the need for foliar application of fungicides later in the season. Although the application of fungicides is almost always effective, their non-target environmental impact and the development of pathogen resistance have led to the search for alternative methods, especially in the past few years. [3,4]



Seedborne pathogen analysis in laboratory

Physical treatments that have already been used in the past and treatments with biopesticides, such as plant extracts, natural compounds and biocontrol agents, have proved to be effective in controlling seedborne pathogens. These have been applied alone or in combination, and they are widely used owing to their broad spectrum in terms of disease control and production yield.

Healthy seed plays an important role for the successful cultivation of all types of crops. Crop response to other inputs largely depends on quality seed. It is estimated that good quality seed alone can contribute about 18 to 20% increasing crop yield keeping all the other inputs constant. However, there are many factors that affect seed quality especially health quality of seed such as all biotic and abiotic factors. Among various factors that affect seed health are the seed borne pathogens that not only subordinate seed germination, but also reduce seed vigor resulting in low yield and yield components of all crops.[5,6] Seed borne pathogens not merely the cause for reduction of germination capability of crop seeds but also responsible for variation of plant morphology in the field and reducing yield up to 15 to 90%. Therefore, it is important to maintain the seed health by using different scientific seed health examination and treatments.

Pathogenic fungi can infect seeds internally and destroy the endosperm and the embryo or contaminate the seeds and affect seedling germination and development. In this paper, seedborne pathogens are defined as any infectious agent carried on the seeds, internally or externally, that has the potential to cause disease in either seeds or the developing plants. Certain seedborne pathogens primarily cause disease of seeds and have minor effects on other developmental stages of trees. Seed is the basic unit in crop production technology. It has attracted the agriculturist even in early days. Seed plays a vital role in associating micro-organisms which prove hazardous for the seed or new plant created from it. Important seed borne pathogen/ microorganism are various fungi, bacteria, viruses, nematodes etc.[7,8]

Seedborne disease

The associated micro-organism may be pathogenic, weak parasite or saprophytes. They may be associated internally or externally with the seed or as concomitant contamination as sclerotia, galls, fungal bodies, bacterial ooze, infected plant parts, soil particles etc. mixed with the seed. Seed borne pathogen generally plays a negative in human welfares as well as agriculture production.

Seed borne pathogens causes diseases at various stages of crop growth from germination of seed up to crop maturity and heavy losses have been observed, caused by seed borne pathogen in various crops. Seed borne pathogens causes seed and seedling rots, i.e. pre- and post- emergence losses, diseases at various stages of crop growth like root rot, stem rot, fruit rot, wilt, blight, leaf spot etc influence the crop stand and ultimate yield. Therefore, the good seed must not be affected by any seed borne pathogen. Pathogen free seed is a factor which needs the maximum attention of farmer for an increase crop production. Thus, detection of plant pathogen from seed and their estimation and management is very important for agriculture production/yield.[9]

Discussion

Externally Seed Borne Pathogen:

The seed inoculum in such cases is superficial and confined to the surface of seed, usually as adhering propagules, e.g., spores sclerotia, mycelium, bacteria, nematodes, virus particles etc. Contamination of seed surface, especially by fungi is often detectable by direct observation under microscope or by examining seed washing.

Internally Seed Borne Pathogen:

The inoculum lies with the tissues i.e., this pathogen are carried inside the seed, usually as adhering by vegetative cell, spores, pycnidia, nematodes or virus particles. Dry seed may look perfectly healthy when examined under a binocular microscope and no signs of infection. Seed borne pathogen established with seed coat, testa, pericarp, endosperm and embryo.

Concomitant Contamination:

The inoculum is present as contamination mixed with seed in the from of infected debris fungal sclerotic, bacterial ooze, nematode cysts, infected soil particles etc. Such contamination is difficult to detect.

Transmission of Seed Borne Pathogens or Disease:

Seed plays a vital role in the transmission of pathogens directly or indirectly. It is essential to understand precisely how the organisms are associated with the seed and get transmitted. The type of pathogen transmitted includes seeds of plant (phanerogamic plant parasite), nematodes, fungi, bacteria and viruses.

Plant pathogens are seed transmissible by

1. adhering to seed surface
2. becoming internally established with in the seed and
3. Accompanying the seed lot as infected plant debris, soil clad or adhering to containers or otherwise.

Several methods have been developed to detect seed borne micro flora. The method of detection may be general or specific for individual pathogen.

The selection of seed testing method for a particular study is based on certain Objectives.

1. Testing for quarantine purposes.
2. Testing for national seed certification schemes.
3. Testing for evaluating the planting value of the seed.
4. Testing for storage fungi.

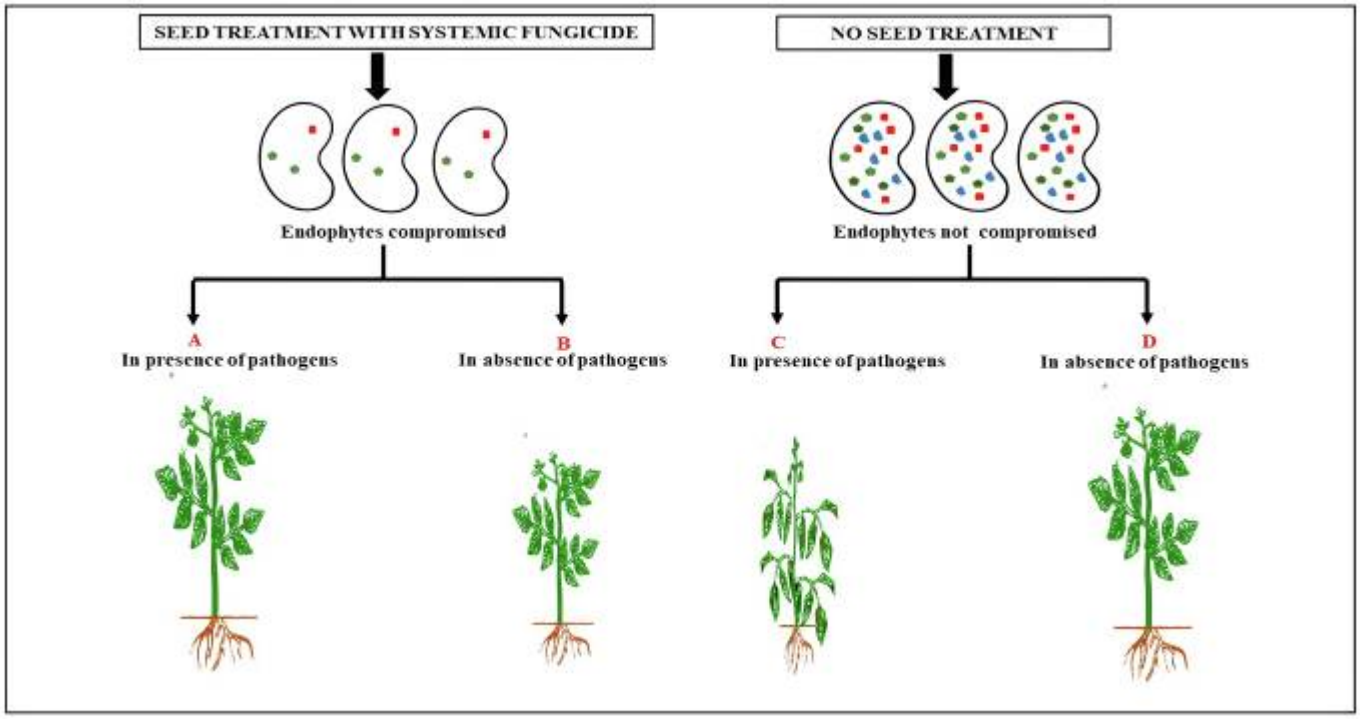
Generally, according to the International seed Testing Association (ISTA) (1999) until and unless otherwise stated, a minimum of 400 seed should be tested for each sample.[10]

Results

A. Management Practices:

1. Seed source-pathogen free seed.
2. Selection of seed-production area and season when and where the seed is not
3. Likely to carry pathogens.
4. Seed-field inspection.
5. Seed certification.
6. Quarantine.

The measures 1st to 4th attempt elimination and 5th is for avoidance.[11]



B. Cultural Practices in Seed-Production Fields:

1. Sowing methods, e.g., deep sowing and planting.
2. Pathogen control in seed field- control of weed hosts, production including pre- harvest earhead spray with fungicides as in wheat or rice if there is rain.
3. Avoidance of overhead watering -Ditch irrigation, rather than sprinkler irrigation is favourable for seed crops. This is particularly true in semiarid areas where foliage would otherwise remain uninfected.
4. Harvesting method- Delaying harvesting, and various cares taken during harvesting.[12]
5. Eradication of infected host plants- Applicable when a disease is newly introduced in an area.
6. Ageing of seed to utilize the phenomenon that some seeds remain viable for a period longer than the period of survival of the pathogen, as in cucurbits.
7. Treatment of field soil-Occasionally effective.

The measures are against the directed reduction of established inoculum. The measures 3rd arid 4th also reduce inoculum build up.

Seed borne fungi

C. Curative or Eradicative Measures for Seed already Contaminated:

1. Seed indexing.
2. Separating procedures.
3. Chemical seed treatment.

Seed treating chemicals with low mammalian toxicity such as antibiotics (aureofungin, blasticidin, etc. against rice blast and brown spot), organic sulphur, systemic fungicides and their combinations (thiram+carboxin; thiram+bavistin, etc.) have been developed to replace organic mercury.[13]

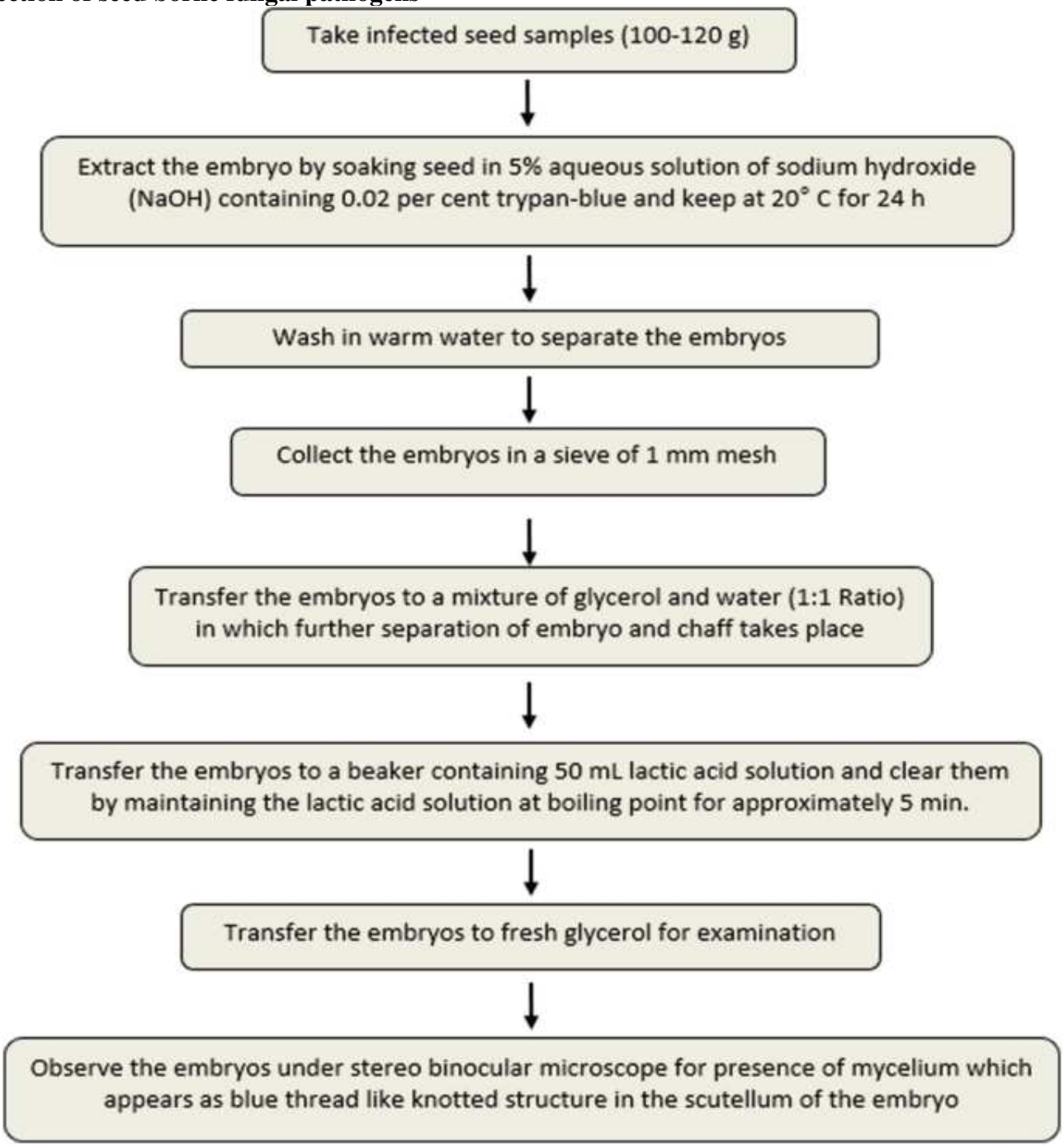
4. Thermotherapy of seed:

The above measures are intended for reduction of established inoculum.

D. Breeding for Resistance against Seed Transmission:

That the amount of primary inoculum should be limited in seed should be the chief objective of control of the diseases due to seed borne pathogens. Thus, breeding disease resistant varieties is likely to be a very successful measure against these diseases. The integration of different measures would be necessary for the evaluation of a recommendation for any specific case.

Detection of seed borne fungal pathogens



Conclusions

Seed borne infection by pathogens causes losses to plant and plant produce resulting in serious economic losses of both time and money.[14] The Seed borne infection may occur either before or after harvest of the plant and its produce. The seed borne infection caused by pathogens normally occurs due to lack of poor handling and harvesting techniques. The quality of the plant grown from infected seed cannot be improved once the plant started germination. The seed borne infection after germination moved to the young seedling first into the root stem then into the leaves and subsequently into seed. [15] However, this loss can be control by following important cultural methods in addition to careful harvesting, handling and packaging techniques. Also careful use of recommended chemicals before and after harvest may prevent seed borne infection and maintained the

freshness of the seed for a considerable length of time by protecting them against pathogens and other environmental factors[16]

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