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MANAGEMENT OF SEED-BORNE DISEASES AND SEED HEALTH IN ORGANIC FARMING#

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Abstract

Organic Farming is nowadays gaining wide impetus due to the minimum adverse effect on the soil health and the ecosystem. However, it has reversibly impacted the seed quality and the development of seed borne diseases. Several Seed treatment methods are available which can reduce the losses due to the various biotic factors affecting seed quality and vigour. This will not only increase the yield per se but also improve the health of human beings.

Key words: Organic farming, seed treatment, vigour, yield

#General Article

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Introduction

The universal need for a sustainable agriculture stimulates the researchers as well as producers to go for an alternative production method "The Organic Farming". The important aspects of organic crop production are abandoning the chemical crop protectants, use of organic manures instead of chemical fertilizers and certification of the organic production system. The latter is important for consumers in justification for paying higher prices for organic products. Many states in India have laid down the regulations for organic production methods spelling the measures that are allowed for production and certification of the produce. A prerequisite for organic farming is that seeds or other propagation materials should also be produced under organic farming situations. Organically produced planting material is quite easy in the case of vegetables like potato and tomato but it is very difficult to produce organic seeds of same standard as in conventional farming in other vegetables especially biennial types like Cole crops, carrot, radish, onions etc. and arable crops or ornamentals. The vegetable crops needing two seasons for seed production are more prone to the risk of contamination of pathogens as compared to short duration crops. In many vegetable crops, germination of organic seeds is lower than the conventional seeds due to high fungal contamination in former. In case of cereals, often low emergence was recorded in organic seeds of wheat because of higher *Fusarium* infection (Steven *et al.,* 2004) and other seed-borne diseases (Borgen, 2004).

The organic seed production is often more expensive than conventional seed production varying from a few percent to three fold due to losses during seed production or insufficient quality of some seeds (van der Zeijden, 2003). Strategic research is essential to tackle the problems associated with organic seed production and seed treatment measures. The first fundamental problem organic farmers frequently face during seed production is risk of contamination with weed seeds and seed-borne pathogens as use of chemical pesticides is avoided and secondly sowing of seeds in soils with organic manures that has slower mineralization rate at low temperature resulting in slower growth of root system of the newly borne seedlings and as such stronger competition from weeds may require a high seed vigour and seedlings with a faster developing root system. Increased risk of seed contamination with seed-borne pathogens might theoretically also increase the risk of crop contamination with mycotoxin producing fungi. These challenges need to find out solutions by developing adequate methods for detection of pathogens during seed production and determination of critical control points for monitoring activities and treatment of the seed crop. The techniques of seed sanitation and treatment need to be developed as alternatives for the present use of fungicides. The treatments need not only be effective in elimination of pathogens but should also maintain the viability of the seeds. Novel seed sorting techniques may also be developed to sort out diseased seed from contaminated lots or discarding less vigorous seeds. Collaborative efforts of seed industries, research workers, organic farmers and policy makers may combat such problems. Some examples of researches on maintaining the health and vigour of organic seeds are presented here.

A. Seed Treatment

Seeds have been contributing a paramount part in survival, transmission, dissemination and migration of pathogens world-wide in crop plants. Seed-borne diseases cause a serious loss in production and some times cause a total failure of the crops (Borgen, 2004). Seed treatment practices in the conventional farming system involve extensive use of synthetic crop protectants such as fungicides, insecticides and antibiotics in different forms and formulations to eliminate seed-borne pathogens and to protect emerging seedlings from soil– and air-borne pathogens and insects. For organic agriculture, many of modified methods should be practiced to overcome the numerated problems.

1. Hot Water Treatment

As a result of omission of chemicals n organic farming system the crops are more prone to occurrence of diseases until the producers avail resistant varieties. In practice, as long crops are exposed in the field condition, as much risk of occurrence of diseases and insect-pest and contamination of seed is there. There should be a threshold describing the link between measured seed contamination level of the pathogen and the potential disease risk in practice. In vegetable crops many diseases are identified to be caused by seed-borne pathogens. For example, *Alternaria* leaf spot in carrot and radish (*Alternaria dauci* and *A. radicina*), black rot of Cole crops (*Xanthomonas compestris*), *Fusarium* wilt of legumes and Cucurbits (*Fusarium oxysporum*). In field experiments of carrot (*Daucus carota* **L.**), Groot *et al.* (2004) used basic seeds of six different cultivars with various levels of *A. radicina* to raise crop in organic conditions. Disease transmission was studied in all stages of seed production chain, from seed to seed. The disease transmission thorough highly contaminated basic seeds could be noticed by blotter or malt agar method (ISTA, 2003) in the form of poor emergence and occurrence of symptoms in seedling stage and leaf stems but slight seed infection resulted in non-violent latent infection in crown part of roots which become visible as a black rot either at high temperature ($>20^0$ C) i.e. during maturation or cool storage as identified through ARSA method (Prior *et al.,* 1994). Such latent infections result in infected flowers and diseased seeds and form a source inoculum for secondary infection of seeds developing from healthy plants.

The organic seed production crop requires a high degree of sanitation i.e. disease freedom of basic seed, rouging in any stage of plant development and a stringent isolation of production fields from other Umbelliferae. Hot water treatment of basic seeds of the same varieties exhibited a high level of disease free flowering plants (only 0-5% infected plants) as compared to non-treated seeds (25-55% infected plants).

2. Seed Treatment with Natural Compounds

In organic production system, merely physical treatment of seeds e.g. hot water involves the risk of seed damage. A combination therapy, involving mild hot water treatment followed by treatment with compounds with natural origin viz., thyme oil, ascorbic acid, Neem oil, etc. proves to be more effective in view of low risk of seed damage and efficient elimination of pathogens. Within this concept, different essential oils and organic acids have been tested by Groot *et al.* (2004) in context of activity against important seed transmittable plant pathogenic bacteria and fungi *in vitro* conditions. Out of

30 essential oils, they found highest inhibiting activity of thyme oil against *Xanthomonas compestris* pv. *compestris* and *Clavibacter michiganensis* subsp. *michiganensis*. Thyme oil also showed an inhibiting activity against *Botrytis aclada* and *Alternaria dauci*. Application of chelator and natural detergent resulted in strong synergistic effects of this oil in eliminating the pathogens. Treatment of cabbage seed for 0.5 h with 0.25% thyme oil resulted in a drastic decrease of seed associated bacteria (>99%) and saprophytic fungi. However, a negative effect on germination was found with oil concentration exceeding 0.25% when applied for at least 4 h.

Ascorbic acid in a concentration of 2.5% also resulted in a decrease of seed associated bacteria without affecting seed germination.

Seed dressing with vinegar has been proven to be effective against common bunt (*Tilletia tritici*) and leaf stripe (*Pyrenophora graminea*) in wheat (Borgen and Nelsen, 2001).

Use of natural oils, organic acids or compounds should be in accordance of national and international regulations for crop protectants, even if they are already used in food products. The products not registered for use as crop protectants need submission of new dossiers often requiring costly toxicological studies that are not feasible for small market of organic seed treatment.

3. Seed Treatment with Mustard flour

In Germany, seed dressing with mustard flour called 'Tillecur' was found very effective against common bunt (*Tilletia tritici*) in wheat (Borgen and Kristensen, 2001) although in Denmark, use of mustard flour as seed dressing is not permitted as it is not listed in Annex II b in the EU Regulation on organic farming.

4. Seed Treatment with Bioagents

Biological treatment of seeds and seedlings with bacteria or fungi are a potential mean of controlling seed- and soil-borne diseases. Different products of bioagents like *Trichoderma viride, Pseudomonas chlororaphis* (Cedomon) etc can be used in organic farming. Although, EU Regulation on Organic Farming looks use of bioagents parallel to problems related to pesticides. The use of bioagents is pesticide-free control measure that promotes beneficial life-forms rather than actively kills pathogens. Nevertheless, this method of control of pathogens in organic agriculture implies a dilemma as it involves use of a single or very limited number of micro-organism which may disturb the existing balance in the soil flora and the use of non-indigenous species not already present in the local soil is certainly questionable in organic agriculture. It is just analogous to the problems raised against use of single chemical compound isolated from plants although plant juices can be used in plant protection in organic agriculture (Borgen and Davanlou, 2000).

Milk powder is also found effective for partial control of common bunt (*Tilletia tritici*) but full control can only be reached at doses where germination and vigour of seeds are reduced (Borgen and Kristensen, 2001). However, milk powder in combination with bio-control agents exhibit synergistic effect (Borgen and Davanlou, 2000).

B. Seed Priming

The release of nutrients in organic soils depends on the microbial activity which leads to decomposition of organic matter. The latter is temperature dependent. Nutrients form inorganic fertilizers are more readily available as compared to organic manures used in organic farming system because of low microbial activity at low temperature during winter season. In winter season vegetable crops, vigorous seedlings with fast growing root system are more competent in drawing minerals and improve establishment of the crop escaping the weed competition for nutrients and light. Manual and mechanical weed removal is more cost-intensive in organic farming as compared to application of weedicides in conventional farming system. Therefore, healthy and vigorous seedlings are desirable for organic farming of vegetable crops. Seed priming is found to be resulting in more healthy and vigorous seedlings in onion and carrot in organic soils as compared to non-primed seeds (Groot *et al.,* 2004). Although, workers here mentioned did not found significant difference in ultimate yield of the crops from primed and non-primed seeds however, seed priming is assumed to result in higher yield particularly in circumstances favouring disease and insect infestation in the crop.

C. New Seed Sorting Technologies to Improve the Health and Quality of Seed Lots

For organic farmers, seed lot with a high vigour is more important than for conventional farmers. Commercial seed lots are composites of seeds harvested over different periods of time and differing in quality. A major cause of the heterogeneity is the variation in maturity, resulting in a seed lot with an overall lower seed quality. During maturation, seeds reach optimal physiological quality. Seeds, which are not completely mature have slow germination, produce less normal seedlings, can have higher contamination levels with pathogens, and can be more sensitive to diseases. In this respect seed maturity has a large influence on seed vigour. After filling of the seeds has completed, colour changes from green to a colour variable with species or cultivar due to chlorophyll breakdown so called 'degreening' process. The latter correlates with seed maturation. The maturation, one of the parameters of seed vigour is distorted by poor plant nutrition, poor weather conditions, presence of pathogens or an early harvest. The colour sorter used for upgrading the seed lots is based on absorption of wavelengths related to chlorophyll as well as other pigments occurring in seeds due to cultivar and production conditions. The Chlorophyll Fluorescence (CF) sorting methods analyses the amount of chlorophyll pigment in the seed by measuring the CF signal in a very sensitive manner (Jalink *et al*., 1998). Thus, based on intensity of chlorophyll florescence signals individual seed/seed lots can be categorized in to various classes of performance.

Cabbage seeds with lowest amount of CF and hence most mature provided indeed the highest percentage of germination, a higher speed of germination, a more uniform germination, a higher percentage of normal seedlings and lower amount of pathogens. Seeds from the high CF fraction, involving less mature seeds, showed a lower germination capacity and were more heaviy infected than the seeds from low CF fraction (Jalink *et al.,* 1998). Similar relationship was also established between the CF signal and the level of contamination with *Fusarium* spp and *Cochliobolus sativus* pathogens in barley (Konstantinova *et al.,* 2002). However, Olvang (2004) observed maximum seed kernal

infestation particularly by *Bipolaris sorokiniana*(the causal agent of Kernel Bunt) occurred during a three week period before harvest of spring barley and wheat in Uppasala, Sweden and suggested that a harvest 15 days earlier than normal would improve the health of seed for organic farming. It is therefore, comprehensive to study the ecological conditions in which there is maximum occurrence of different diseases in a particular crop. The same theory was also advocated by Olvang and Person (2002)

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