9 CHAPTER

Seed Treatment, Procedures and Equipments

9.1 WHAT IS SEED TREATMENT

MANUSMRITI, an ancient Indian scripture, which dates back to about 5000 years proclaims that SUBEEJAM SUKSHETRE JAYETE SAMPADYATE, meaning thereby that good seed in good soil yields abundant. This clearly indicates that our ancestors were quite aware about the significance of quality of seed. Therefore, every care needs to be taken to ensure that the seed used for cultivation is of good quality, having high levels of germination, vigour, purity and health. This can be achieved by taking necessary steps during seed production, harvesting and processing and by enhancing the quality through an array of post-harvest/pre-sowing treatments.

Treatment of seeds is not an innovation of modern science. Ever since agriculture came into existence, seeds are being treated in one way or the other to protect the resulting crop from the ravages of plant pathogens. In *Surpala's Vrikshayurveda* (800AD), it is documented that the seeds steeped in milk and rubbed in cow-dung followed by drying and then repeatedly rubbed in honey to which powder of *Vidanga* (*Embelia ribis*) is added, grows successfully. Further, the seed after extraction from the fruits, if steeped in milk and dried for five days, followed by fumigation with the fumes of ghee to which *Vidanga* is added, produce healthy and vigorous seedlings.

Tull (1733) observed that the wheat consignment contained in a vessel when sank near Bristol, rendered the grains unfit for human consumption as it was soaked in brackish water of the sea. However, these wheat seeds were purchased and sown in the fields by the farmers of that area. Consequently, it was indeed a matter of great surprise to them that the wheat crop sown in and around England was infected with bunt while a healthy crop emerged from the minimize the residues and loss of chemicals and pesticides by adopting precise and more effective application procedures, *viz.*, film coating, pelleting, priming with or without nutrients or bioactive substances etc. Thus, seed treatment includes:

- Application of a pesticide to control pests and pathogens during storage, field emergence and later stages of crop growth.
- Dusting of the seed with inert powder or other colouring material or coating with polymers to improve the physical properties and visibility of seeds in furrows.
- Pelleting the seeds to have a uniform size and shape for better plantability.
- Priming the seed to alter its physiology for improved performance.
- Application of biological fertilizers like *Rhizobium* and many other bio-control agents.
- Novel techniques including film coating through which pesticides, biological agents and other systems could be added to the seed.

9.2 PESTICIDAL SEED TREATMENT

A number of seed borne diseases can be controlled by topical application of the fungicides irrespective of the nature of formulation. Siddiqui *et al* (1987) were able to control downy mildew of pearlmillet caused by *Sclerospora graminicola* by treating the seed with Apron, a DS formulation of metalaxyl. Gaur and Sharma (1992), while working on loose smut of wheat caused by *Ustilago segatum* var. *tritici*, could find a dry seed treatment of wheat seeds with Raxil (-2-(-chlorophynyl) ethyl (-1,1-dimethyl-ethyl)-1,4,-1,2,4-triazole-ethanol) quite effective. Wainwright *et al* (1994) found liquid or flowable formulations of tebuconazole and triazoxide for the control of some seed borne disease of barley.

9.3 SEED COATING

Coating refers to the direct application of a substance/material, botanical or synthetic, to the seed so as to cover the outer surface uniformly. Seed coating provides a mechanism for effective and uniform application of active formulations at seed-soil interface, protecting against pathogens and pests, as well as regulating moisture uptake, particularly in sub-optimal conditions (Scott, 1987).

and field emergence under favourable conditions to avoid injury and seedling mortality (Landec Corp., USA).

9.4 PELLETING

Pelleting technique was introduced in the USA in 1940 and in Europe in 1960. The process involves rolling of seeds either together with the pesticides, nutrients, fillers and binders with gradual addition of water followed by drying, or to add various components in incremental layers to the seeds until the correct size/grade of pellet is reached. Pelleting is a batch treatment and allows coating of individual seed without causing agglomeration. The irregularly shaped seeds become uniform by pelleting, facilitating precision drilling for optimum plant stand.

There are two components to a seed pellet, a bulking (coating) material and a binder. The bulking materials can be a mixture of several different minerals and/or organic substance or a single component. The coating materials change the shape, size and weight of seeds. It is important that the coating material should have uniformity of particle size distribution, availability and lack of phytotoxicity. The other component of the pellet the binder, holds the coating material together. The concentration of the binder is critical as too much binder hinder germination and too little result in chipping and cracking in the pellet. Different materials can be used as binders, including various starches, sugars, gum Arabic, clay, cellulose, vinyl polymers (Halmer,1988).

9.5 SEED PRIMING

Heydecker (1973) defined seed priming as 'a presowing seed treatment in which seeds are soaked in an osmotic solution that allows them to imbibe water, go through the first two stages of germination, but does not permit the radicle protrusion through seed coat'. In the subsequent years, the term priming has been used to encompass a wide range of seed treatments through which the seed is metabolically advanced, giving it an advantage of early and uniform germination upon sowing.

These primed seeds can be dried back to the original moisture content and stored (normally for a short period) prior to sowing.

In seed priming regime seed water potential is maintained at a level sufficient enough to initiate metabolic events in phase II of germination process (Bewley and Black, 1994), but which prevent radicle emergence. Several methods have been described to regulate water availability to seeds both as a liquid and in vapour phase (Khan, 1992).

The controlled hydration of seeds can be regulated osmotica (osmopriming), salt solution (halopriming) and inorganic or organic carriers (solid matrix priming).

9.5.1 *Osmopriming*

Soaking seeds in an osmotic solution of polyethylene glycol (PEG 6000) or mannitol allow seed to imbibe water but do not permit radicle protrusion. Once the seeds are removed from PEG and imbibed in water all of them germinate and emerge at the same time. Successful priming depends on treatment duration, temperature, aeration and the water potential of the priming solution. An aerated column can be used for osmopriming. Seeds are placed in a glass cylinder with osmotic solution and are aerated through a glass tube connected by rubber tubing to an aquarium pump. Generally the priming is performed at 25°C for desired time in an incubator. To maintain the constant volume of osmotic solution, distilled water is added. After the completion of the soaking duration, seeds are removed and washed with water. Seeds are then dried back to their original moisture content.

9.5.2 *Halopriming*

Halopriming is performed by soaking seed in salt solution of KNO_3 (Potassium Nitrate) or K_3PO_4 (Potassium Phosphate) at a concentration of 15 to 30 mM. Soaking period varies from 6 to 24 hr depending upon the crop species and temperature. Some times solutions containing $MnSO_4$, $MgCl_2$ and $NaNO_3$ are also used. Compared to PEG, salts are easier to aerate and to remove from the seed after treatment, are less costly, and may provide nutritional effect.

9.5.3 *Solid matrix priming*

The considerable volume of solution required per seed and problems with aeration of the solution can become obstacles when priming large-seeded species or large quantities of seed. Solid matrix priming (SMP) consists of mixing seeds with an organic or inorganic carrier and water for a prescribed period of time. The moisture content of the mixture is brought to a level just below that required for radicle protrusion. Seed water uptake is regulated by the matric potential of the seed. Different materials have been used as solid matrix-priming agent. Vermiculite, Calcined clay, Microcel E, Bituminous coal and Sphagnum moss are some of them being used successfully in vegetable seeds. The advantage of SMP system is that it minimizes aeration problems and facilitates the incorporation of other types of products into the mix. Fungicides and *Trichoderma* strains are commonly added.

Table 9.1 Priming techniques used successfully in some horticultural crops

Crop	*Priming technique*	*Remarks*
Bittergourd	Solid Matrix priming Hydration Osmopriming	Vermiculite, 20°C for 48h Wrapping in moist muslin cloth, 20°C for 48h Mannitol (−1.0 MPa) for 3 days at 25°C
Carrot	Osmopriming	PEG 6000 (−1.0 MPa) for 3 days at 25°C
Cauliflower	Osmopriming Halopriming	PEG 6000 (−1.0 MPa) for 6 days at 25°C KNO_3 (15 mM) at 25°C
Chilli	Solid Matrix Priming	Vermiculite, 25°C for 48h
Okra	Solid Matrix Priming Hydropriming	Vermiculite, 20°C for 20h Water soaking at 20°C for 20h
Onion	Osmopriming Halopriming	PEG 6000 (−1.0 MPa) for 6 days at 25°C $MgNO_3$ (10 mM) at 25°C
Papaya	PGR	GA_3 (2.0 mM) soaking for 24h
Tomato	Osmopriming Halopriming	PEG 6000 (−1.0 MPa) for 6 days at 25°C KNO_3 (15 mM) at 250C

(Nagarajan, S., 2005).

9.6 PHYSICAL METHODS OF SEED TREATMENT

There are different types of physical treatments using radiation, temperature, magnetic and microwaves, controlled gaseous atmosphere etc., which are effective in maintaining or enhancing the seed quality.

Post harvest preservation of seeds and grains is achieved by fumigation with methyl bromide or contact treatment with an appropriate pesticide. This is widely practiced due to low cost, fast speed in processing and ease of use. However, concerns have been raised about the health hazards of chemical pesticides and its environmental pollution leading to research on the ionizing radiations, controlled atmosphere, cold treatment, conventional hot air, and radio frequency and microwave dielectric heating for preservation of seeds, grains and other agricultural produce.

Controlled atmosphere (O_2 below 1% and CO_2 above 20%) and chilled aeration have been used to control stored product insects in grains. Forced hot air is used as an alternative treatment to the chemical fumigation. This method is limited due to external and internal damage caused by heat over long exposure times including peel browning, pitting and poor color development.

Ionizing radiation like gamma rays, high-energy electrons and X-rays are used to sterilize, kill or prevent emergence of insect pests in food. Due to the high initial investment to establish irradiation facilities and disposal of radioactive wastes this technology has not been widely favoured or accepted.

Radio frequency (RF) and microwave (MW) heat treatments reach the same level of insect mortality in a shorter time. Nelson (1996) summarized research on the susceptibility of various stored grain insect species to RF and MW treatments. The Federal Commissions allocated five frequencies of RF and MW to industry, scientific and medical applications i.e., 13.56, 27.12 and 40.68 MHz for RF, 915 and 2450 MHz for MWs.

The short time exposure to RFs and MWs makes it possible to design continuous treatment of large quantities of products in a short period of time. This reduces the labor cost, use of space and results in less mechanical damage. These processes are safe to operators and have little impact on the environment.

Baker in 1952 coined the term thermotherapy for wet or dry heat treatments to control seed borne pathogens.

9.7 METHODS OF SEED TREATMENT

9.7.1 Drum Mixing

The most convenient and primitive way of treating the seed is dry dressing. In this method, a dry formulation of the fungicides is used, which includes the active ingredient and an inert matter which is also termed as carrier. The formulation may also contain additives to prevent formation of lumps or stickers to improve adhesion to the seed surface. The greatest advantage of this method is that it can be used at any place even at farmer's field without any specific equipment. However, the disadvantage is that sufficient amount of chemical is wasted during the treatment. Coating of the chemical is also not uniform on seed surface. Many seed companies including National Seeds Corporation used to supply the chemicals separately in a small pouch along with the seed packet.

9.7.2 Slurry Treatment

A wettable powder is suspended in water to make a slurry. A known quantity of slurry and the seeds are dumped in a mixing chamber where they get blended. The operation of slurry treater is relatively simple. There is a metering device through which a known quantity of seed is dumped every time in a mixing chamber. Similarly, the amount of treating material is regulated not only by the

slurry concentration but also by the size of the slurry cups. This is so adjusted that one cup of slurry is added to each weighed dump of the seed in the mixing chamber which is provided with an auger type agitator that mixes and moves the seed to the discharge end of the chamber. The auger may be one of several types such as rods, curved paddles or brushes. The brush auger is used for seeds which are susceptible to mechanical injury, e.g. soybean. Normally, the slurry treater has uniform size of cups which have drain ports and rubber plugs for 15, 23 and 46 cc quantities. With all the bottom port plugged, they deliver 46 cc of slurry each time. Slurry tanks are provided with agitators to keep the powder in complete suspended form during the operation.

9.7.3 Mist-o-Matic Seed Treater

The mist-o-matic seed treater applies the treatment directly to the seed in the form of a mist. A small treatment cup operating through a rocker arm takes the chemical out from a small reservoir. After metering, the treatment material flows to a rapidly revolving fluted disc mounted under a seed spreading cone. The disc breaks the drops of treatment material into the mist and spreads it outwards to coat the seeds falling over the cone through treating chamber. Cup sizes are designed by the number of cc's they actually deliver e.g. 2.5, 5, 10 and 15. The treater is equipped with a large treatment tank, a pump and a return tube that maintains the level of the treating material in the small reservoir from which treatment cups are filled.

9.8 Film Coating

Film coating requires the application of a thin, durable, water permeable coat, usually a polymer binder, which can be used to contain pesticides and other products securely, so that they may have maximum effect at the time of sowing. This technology was developed in United Kingdom in eighties. In terms of added material, the film coated seed lie between the slurry treated seeds and pelleted seeds. Major advantages of film coating are : accurate pesticide dosing and effective applications of biological control agents with high retention of product on the seed.

Future Prospects

Since physical seed treatments like hot water treatment and aerated steam treatment have limited commercial application, a detailed appraisal of the effects of wet heat treatment should be accomplished to improve the efficiency of physical seed treatments. Conceptually the future of seed treatment technologies appears to be very bright. Pelleting system with possible innovations of man-made or natural pesticides have good scope in the future. There are considerable opportunities for the use of priming with vegetable and flower seeds. The new non-osmotic method of drum priming, where water supply to the seeds can be controlled by physical rather than chemical means is much more preferred as compared to other modes of seed priming. Film coating technology has already become a commercial reality for vegetable and flower seeds. The use of polymers enables slow or continuous release of pesticides which results in the establishment of healthy and vigorous seedlings.