An Eco-friendly Seed Coating Technology for High Value Vegetable Seeds

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Abstract—*In high-value, low-volume crops like tomato, the high seed multiplication ratio and low seed rate often leads to huge quantity of carry over seeds. Seed, being a living entity, is bound to lose its viability over a period of time, which manifests in poor crop establishment in the field. Many seed technological interventions have been successfully attempted for enhancing the seed quality of carry over seeds and polymer film coating is one such promising technology which has been proved to ensure faster and uniform crop establishment. The application of polymer film coating as a delivery system for seed protectants, nutrients and hormones that help in superior field performance has been well established in many crops. However, the use of polymer film coating as a means to maintain seed quality during storage has been less investigated. Hence, the present study was undertaken to investigate the use of film coating technique as a tool for ensuring safe seed storage.*

1. INTRODUCTION

Use of quality seed is the cornerstone of good crop husbandry. Being a biological entity, seed undergoes natural ageing/deterioration immediately after harvest and the extent of seed deterioration determines the plant stand of the subsequent crop. Storage of the harvested seeds under ambient conditions, wherein high relative humidity (RH) and high temperature prevails, accelerates this process of deterioration and causes substantial yield loss. Storage under Low-Temperature Low-Humidity (LTLH) conditions after drying back the seed to safe moisture limits is the assured means for proper maintenance of seed quality. However, since majority of the farmers are dependent on carry over seeds stored under on-farm conditions, it is imperative to have more farmer friendly strategies for ensuring minimum loss of seed quality during storage. Moreover, there is a demand from the commercial seed sector dealing with high value-low-volume horticultural crops, for precision seed quality enhancement technologies. The present study evaluates a novel approach for seed quality maintenance, using film coating technique, which is currently an emerging technique in seed industry for pesticide application.

2. MATERIALS AND METHODS

100g each of freshly harvested seeds of tomato *(Lycopersicon esculentum* Miller*)* cultivar Pusa Rohini were subjected to film coating using the commercial hydrophilic polymer Disco Clear (Incotec International B.V. Ltd, The Netherlands), after 25% dilution with distilled water. The dried seeds were packed in paper bags and aluminium pouches, the latter being heat sealed after manually pressing out air. Seeds were subsequently stored for a period of one year under ambient and low temperature – low humidity (15± 1°C; 30± 5% R.H) – hereafter referred to as LTLH, conditions.

The temporal effect of the polymer film coat on seed quality was evaluated at a periodic interval of 3 months during storage using the following parameters.

Electrical conductivity

50 seeds each were steeped in 25 ml distilled water at 25 ± 1^{0}C temperature for 24 hrs with frequent shaking. The film coat was removed from the coated seeds, prior to soaking, by thoroughly rinsing in distilled water. The conductivity of the leachates was estimated and expressed as -----/50 seeds.

Moisture Kinetics

1 g each of coated and non-coated seeds was kept in three replicates over moist blotter at 25^{0}C and the gain in weight was recorded after 2, 4, 6 and 24 hours.

Another one gram seeds from each treatment were separately weighed and kept in plastic wire mesh bags, within a closed desiccator at 100% RH and at 25^{0}C for hydration, then it was dehydrated and after that rehydrated. The change in weight during the hydration process was recorded after 2, 4, 6, 24, 26, 28, 30 and 48 hours. The hysteresis loops were established as per the procedure described by Moharir and Namprakash (1995),

Antioxidant enzyme activity

Twenty seeds from each treatment were used for detection of superoxide dismutase and dehydrogenase enzyme activities, using spectrophotometric assay. The film coat was removed from the coated seeds, prior to the assay, by thoroughly rinsing in distilled water.

Super oxide dismutase. Super oxide dismutase was assayed as per the methodology described by Beuchamp & Fridovich (1971) with minor modifications.

Dehydrogenase activity. Dehydrogenase activity was assayed by quantification of formazan that developed as a result of the enzyme mediated reduction of 2, 3, 5 triphenyl tetrazolium chloride.

Field emergence

Field emergence was estimated during the initial and final period of storage, by sowing 100 seeds in three replications, using Factorial Randomized Block Design. Observations were recorded on 15th day after sowing and the values were expressed as percentage of seedling emergence.

3. RESULTS

Electrical conductivity

Significant main and interaction effects were recorded six months after storage. Storage in paper bags and under ambient conditions were found to cause an increase in EC values, as compared to storage in aluminium pouches or under LTLH condition. EC values of all film coated treatments were statistically on par and were significantly lower than that of non-coated seeds.

Hydration-dehydration studies

Hydration and dehydration in a vapour saturated atmosphere revealed higher rate of hydration and dehydration for the uncoated seeds as compared to coated seeds. The average rates of hydration and dehydration were lower for the coated seeds (0.00457 and 0.00433), as compared to the uncoated ones (0.00647 and 0.00613).

Imbibition studies

When the seeds were brought in direct contact with free water, the hydrophilic film coat caused significantly higher imbibition, with the film coated seeds recording 141% increase in weight within 24 hrs, compared to 103 % in the case of uncoated seeds.

Antioxidant enzyme activity

The activity of dehydrogenase and super oxide dismutase enzymes displayed a trend parallel to that of other evaluated vigour parameters. Film coating could curtail reduction in enzyme activity to a significant extent, irrespective of the storage conditions. However maximum enzyme activity was retained in case of film coated seeds stored in aluminium pouches under LTLH condition.

Field emergence

Field evaluation study recorded significantly higher percentage of field emergence in coated seeds as compared to non-coated seeds.

4. DISCUSSION

The experiment revealed the efficacy of the film coating technique in effectively maintaining the seed quality during storage, with the major role identified as that of moisture regulation. The presence of the thin polymer film coat over the natural hygroscopic seed coat was found to form a physical barrier for absorption of moisture in the vapour phase and hence the film coated seeds remained protected from equilibration with higher relative humidity to a significant extent. However, when brought in direct contact with water the hydrophilic film coat facilitated uniform and higher rate of imbibition of water by individual seeds. This phenomenon of differential behaviour of hydrophilic film coats when in contact with free water and in a vapour saturated atmosphere has been cited in several earlier works (Dadlani *et al.*, 1992; Baxter and Waters, 1987). Presence of free water has been found necessary for hydration of the film coat since the polymer does not attract water from the surrounding, but simply “immobilizes” water that it comes in contact with (Kaniuaka, 1975).

The uniform and higher rate of imbibition facilitated an increase in speed of germination as well as a greater emergence percentage, compared to non-coated seeds, both under laboratory and field conditions. The data on anti-oxidant enzyme activity and controlled deterioration test confirmed the above observation. The superior germination percentage, hence, may be attributed exclusively to the enhanced imbibition recorded in film coated seeds.

Film coating was found to be a superior alternative to storage under regulated environment, till a period of six months, as indicated by all parameters evaluated in this study. This data is highly relevant in the context of normal on-farm practice, wherein seeds are routinely stored for a period of six months between two consecutive cropping seasons.

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