National Seed Association of India

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Seed Times

The National Seed Association of India Magazine

Seed Conditioning

ABOUT NSAI

National Seed Association of India (NSAI) is the apex organization representing the Indian seed industry. The vision of NSAI is to create a dynamic, innovative and internationally competitive, research based industry producing high performance, high quality seeds and planting materials which benefit farmers and significantly contribute to the sustainable growth of Indian Agriculture.

The mission of NSAI is to encourage investment in state of the art R&D to bring to the Indian farmer superior genetics and technologies, which are high performing and adapted to a wide range of agro-climatic zones. It actively contributes to the seed industry policy development, with the concerned governments, to ensure that policies and regulations create an enabling environment, including public acceptance, so that the industry is globally competitive.

NSAI promotes harmonization and adoption of best commercial practices in production, processing, quality control and distribution of seeds.

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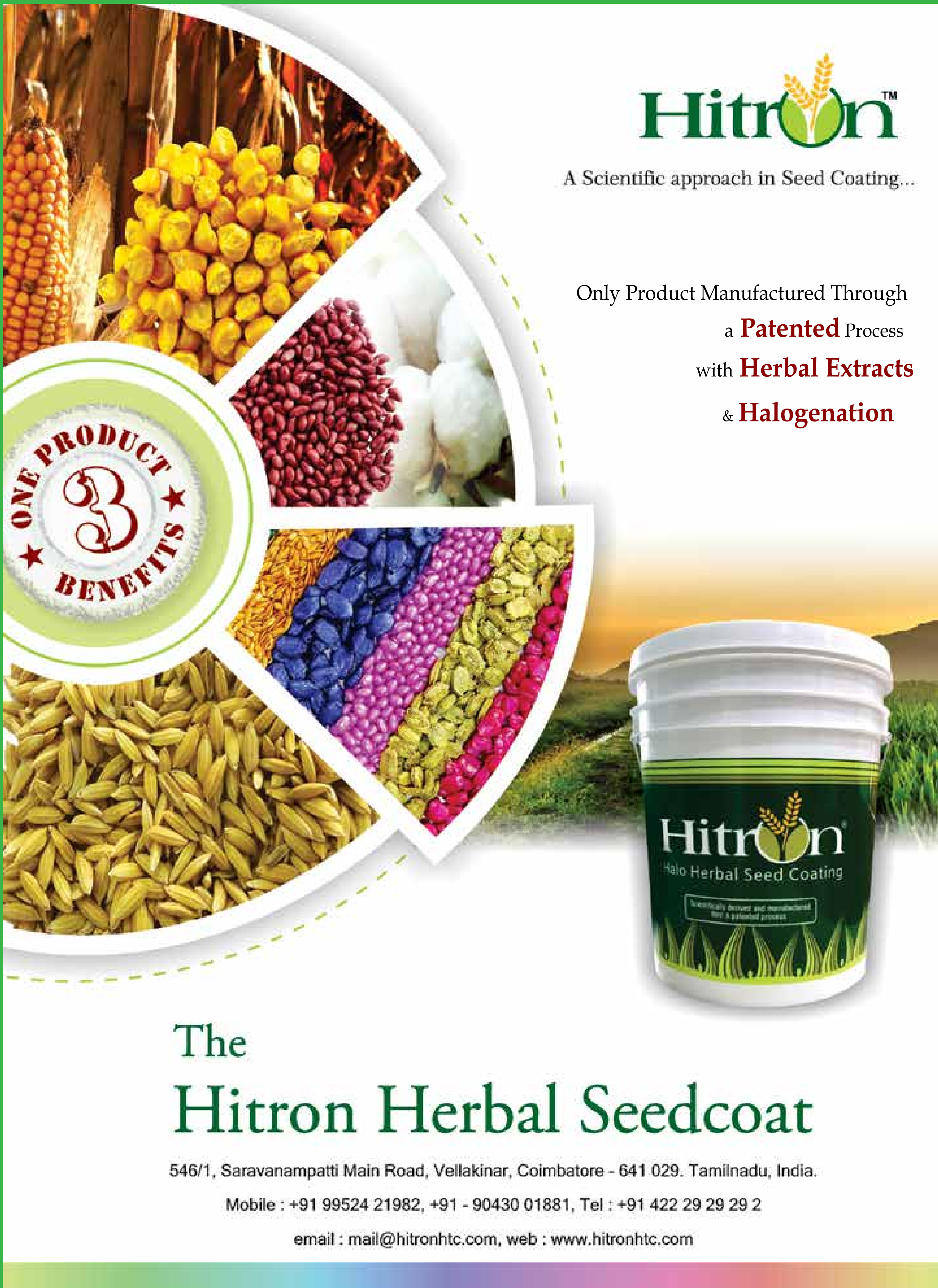
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Message
from Desk of
PRESIDENT

Seed as it comes from the field is almost never pure. It usually arrives at the cleaning plant containing large quantities of trash, leaves, weed segments, other crop seeds, and insects so that it cannot be safely stored, efficiently handled, nor accurately cleaned until most of the foreign material has been removed. So, Seed conditioning play a very important role in ensuring the seed quality. This also ensure and empowered the farmers by producing more yield with fewer external inputs.

Seed industry exists only to supply a better quality of seed to farmers. Thus, the seed industry is entirely a quality program: in all its operations, a seed enterprise seeks high quality achievement at reasonable cost; in all its contacts with farmers, it seeks to give them quality assurance.

I thank the contributors and NSAI team for bringing together this Seed Times on theme Seed conditioning. This creditable objective will improve the knowledge and skills of our seed industry persons in order to deliver quality seeds to farmers.

I hope the readers would greatly be benefited from the magazine.

Happy reading!

M Prabhakar Rao

Message
from Desk of
EXECUTIVE DIRECTOR

The production of high-quality seeds is of prime importance to Seed industry. In the production of any crop, the cost of the seed is usually minor compared with other production costs, yet, no single factor is as important in determining the success of the operation.

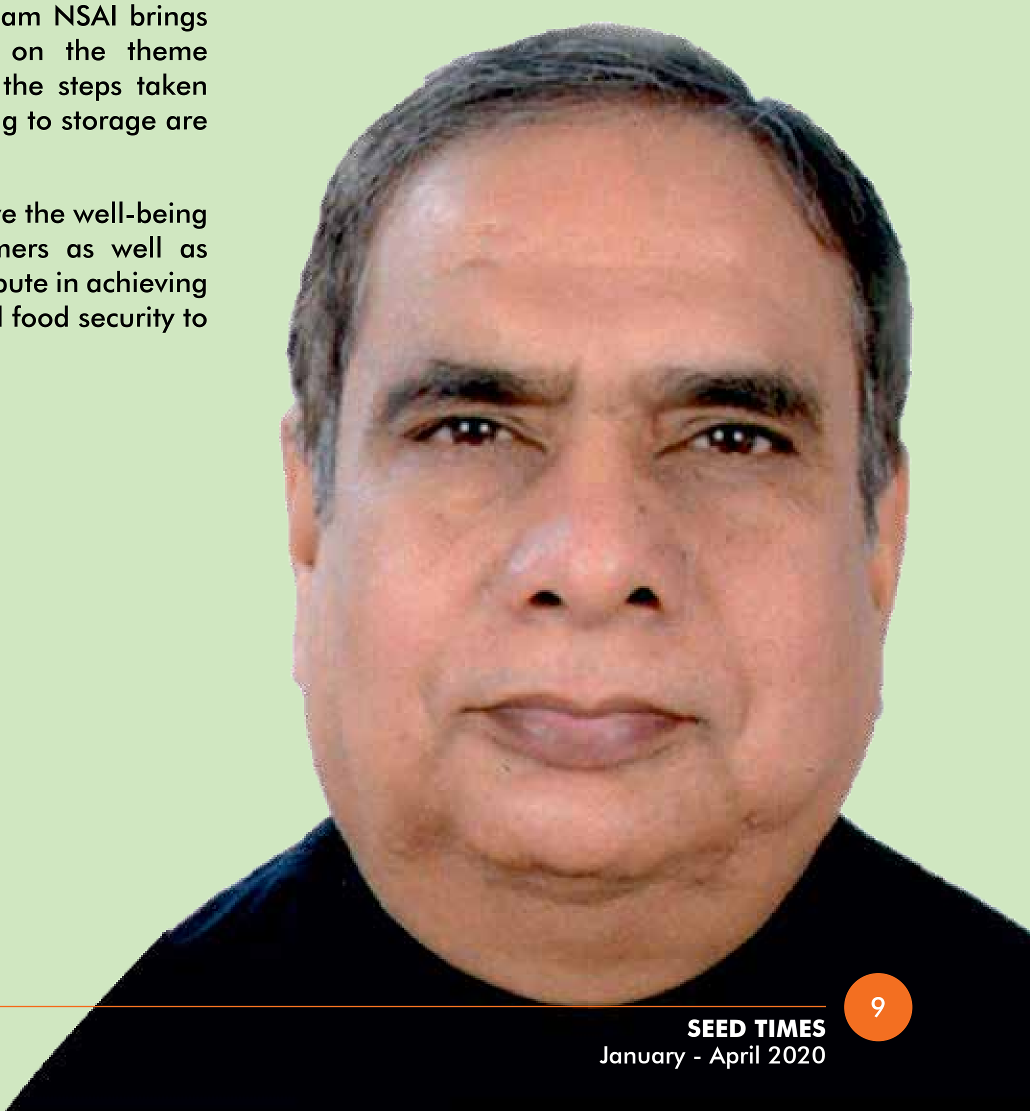
Most crop plant seeds are produced by companies that specialize in both plant breeding and seed production. Growers expect these companies to introduce improved cultivars, as well as to produce high-quality seeds that have good germination characteristics and are true-to-type. To produce high-quality seeds, companies must not only pay close attention to the environment where seeds are produced, but must also have the means to test the quality of those seeds.

In this edition of seed times, team NSAI brings some knowledgeable content on the theme 'Seed conditioning", in which, the steps taken for post harvested seeds cleaning to storage are summarized.

This worthy objective will improve the well-being of our seed industry and farmers as well as ensure the modest way to contribute in achieving sustainable food production and food security to the nation.

Happy Reading!

R K Trivedi



Principles of SEED CONDITIONING

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The process of removing unwanted materials from a seed lot, along with overall improvement of seed quality, is known as seed conditioning. Seed conditioning is the essential post harvest operation necessary for preparing the quality seeds for distribution in the market. Steps of seed conditioning refer to all the steps followed in sequence, viz. drying, cleaning, grading, treating & finally packaging/bagging.

Principles of seed conditioning:

Seed conditioning/processing is an important step to upgrade the seed quality to desired levels and prepare seeds for distribution. The major objectives/Principles are:

(1) Complete separation-removal of all contamination by removing impurities and undesirable materials to the desired levels of purity

(2) Minimization of seed loss-some good seeds are removed along with contaminants in almost every conditioning operation and this loss must be kept at a minimum,

(3) Upgrading-improvement of seed quality through removal of decayed, cracked, broken, insect-damaged, or otherwise injured or low quality seed,

(4) Maximizing efficiency-the highest capacity consistent with acceptable seed quality.

(5) Minimization of labor-labor is a direct operating cost and cannot be recovered.

(6) Apply protective chemicals for controlling seed born organisms and protecting germinating seed from seed rot and seedling blights.

(7) Pack the seed in convenient and marketable containers

(8) To make the seed suitable for storage

The above objectives can be obtained by:

- Grading and cleaning the seeds with Seed graders, cleaners, Indented cylinders/Disc separators, Specific gravity separators, color shorter, Surface texture separator, Spiral separator, Magnetic separator, Electro static separator, etc. depending on the differences in physiological properties of seed e.g. Size, length, weight, surface texture, color, etc.

Seed conditioning is the essential post harvest operation necessary for preparing the quality seeds for distribution in the market. Steps of seed conditioning refer to all the steps followed in sequence, viz. drying, cleaning, grading, treating & finally packaging/ bagging.

- Applying fungicides and insecticides in the form of powder, slurry, liquid with seed treater.
- Drying the seed with dryers to safe and desired levels for packing and storage

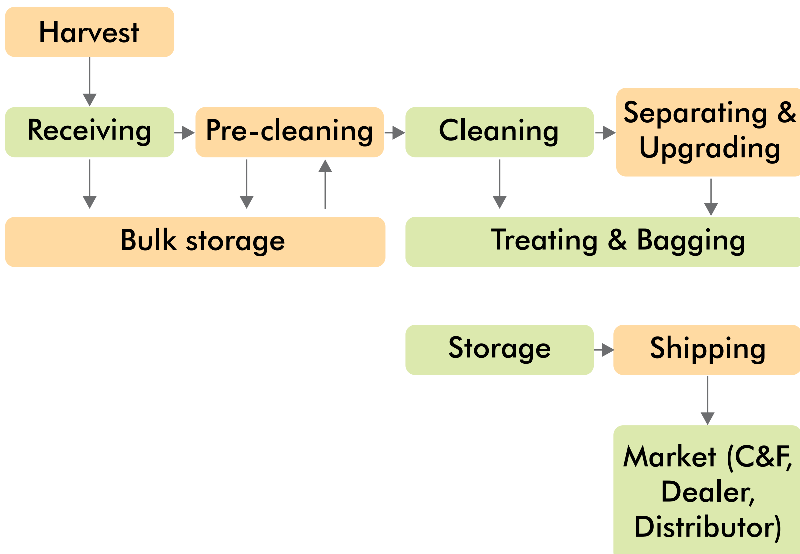
The harvested seed goes from the farm to factory –like processing plants. There the seed is dried, cleaned, stored, treated and packaged ready for sale. A processing plant should better be located near to the producing farms rather than to the ultimate seed purchases. At the same time, for efficient working, the plant should be accessible to big enough quantities of newly harvested seed from the farms to ensure that its capacity is fully/ properly utilized. Other factors are the availability of power, labor & transport system and other infra-structural facilities.

A seed processing plant may be designed to conduct all the processing operations beginning with seed drying to cleaning, grading, and seed treatment and packaging efficiently. For proper functioning of processing plant the following points should be taken into considerations.

1) Area or location where processing is to be made.
2) Availability of power source at the location.
3) Approx. seed quantity and size of capacity of processing unit.
4) Whether drying facility is necessary.
5) Types/ kinds and initial quality of crop seeds to be processed.
6) Kinds of other crop seeds and weed seeds usually or occasionally present in the seed lot.
7) System of delivery of seed to processing unit.
8) Other infra-structural facilities including transportation.
9) Time required for processing of the seed sample.
10) Availability of workers/helpers.

A seed processing plant may be designed to conduct all the processing operations beginning with seed drying to cleaning, grading, and seed treatment and packaging efficiently.

General Conditioning Flow Diagram



The time requirement for processing a seed lot depends on the type/kind and initial and quantity of seed to be processed. Small seeds require more time than large seeds. Certified seeds will require less time than foundation seeds. Seasonal flower and vegetable seeds will require are time than perennial ones. Preliminary consideration in seed processing is to dry the seeds to safe moisture level which would not Impair seed viability during storages. It varies from crop to crop in the orthodox and recalcitrant seeds. Next to drying, the seed is cleaned in the processing plant by scalping, i.e. sieving to remove extraneous material, coarse enough to be easily separated by screens; hulling i.e. completion of the field threshing operation. The awns and appendages of Gramenaceous crop seeds are also removed by additional pre-cleaning operation. The seed is then processed in an air-screen cleaner, in which the bulk of the foreign material is removed by screen and air current. The final cleaning is made on one or more finishing machines, which generally separate only one type of contaminating seed from the desired clean product.

The cleaned seed lot is then processed for size grading. Specific gravity separator is used to separate seeds according to their weight and size. Indent disk and Cylinder separators are used to remove long seeds from the short ones. Pneumatic and Aspirator

The time requirement for processing a seed lot depends on the type/kind and initial and quantity of seed to be processed.

Small seeds require more time than large seeds. Certified seeds will require less time than foundation seeds.

separators will separate seed that have a different resistance to air flow. Velvet roll separators remove smooth seeds from rough seed. Magnetic separators and the buckhorn machine separate rough of sticky surfaced seeds from smooth ones. Color separator divides the light colored seeds from the dark ones. Spiral, inclined draper, Timothy bumper mill, vibrator and horizontal disk separators discriminate seeds according to their shape. Electronic separators sense a difference in the electrical properties of seeds.

The proper grades of seeds are then treated variously by scarifying or scratching the hard coated seed; or by chemical treatment, irradiation, pelleting or adding of Rhizobium to legume seed to condition the seed for better storage life and/ or performance. Final step of processing is to pack the seeds in properly labeled containers for marketing.

Innovation in technology, equipments, & practice in seed conditioning:

Innovations from throughout the seed industry help address many of the economic, environmental and health issues, we face as a global society. Seed conditioning is one of the most important processes to enhance the quality of seed to next level. The seed is harvested from geographically diverse areas of the country and it is transported to NSL plants these heterogeneous lots are technically handled by highly experienced & skilled manpower. NSL Supply chain follows SOPs, protocols & quality assurance processes at every stage of seed handling. We are using advance seed processing & conditioning machines from world's leading seed processing equipment manufacturer Cimbria & Seed procession Holland. We are having 12 operational plants over 7 states of the country.

Innovations from throughout the seed industry help address many of the economic, environmental and health issues, we face as a global society. Seed conditioning is one of the most important processes to enhance the quality of seed to next level.

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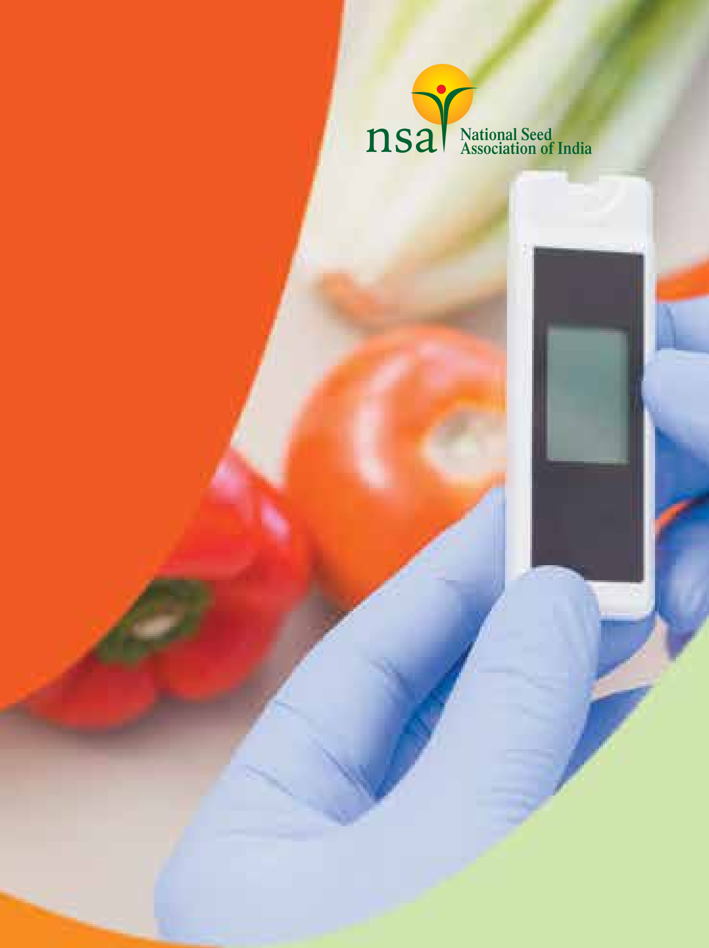

Biological Seed COATING TECHNOLOGY

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Abstract

Biological seed coating is a fastest growing segment in the seed treatment. Biological agents can safely be delivered through coatings on to the seed surface with the help of an adjuvant. Studies on the standardization of Biological Seed Coating Technology were carried out in pigeonpea and maize at the Department of Seed Science and Technology, Seed Research and Technology Centre, Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana. The main objective of the research was to find out the best feasible technology of biological seed inoculation as coating on to the seed surface well in advance of sowing i.e., at the time of processing or before packing. From the research findings, the biofriendly polymer and some coloured polymers were observed to be the best adjuvants compared to farmer practice sugar syrup. Biological agents like Trichoderma viride, Pseudomonas fluorescens, Bacillus subtilis, Bacillus megaterium, Rhizobium leguminosarum showed compatibility with seed coating materials like biofriendly polymer, coloured polymers and thiamethoxame (insecticide). These bioagents recorded partial compatibility with metalaxyl (fungicide) and incompatibility with sixer (fungicide). There was a gradual decrease in the number of colony forming units (cfu) with the advancement of storage period of coated seed. The viable colony units of biological agents were observed on the surface of biologically coated seed even 7 months after coating. All seed quality parameters were observed to be decreased gradually with the advancement of storage period of coated seed under ambient conditions. Under in-vitro conditions, Trichoderma viride showed high bioefficacy against Fusarium udum and Macrophomina phaseolina, causative organisms of Fusarium wilt in pigeonpea and post flowering stalk rot in maize. One month after coating, maize seed treated with Trichoderma viride (5g kg-1 seed) + Pseudomonas fluorescens (10g kg-1 seed) + Bacillus subtilis (10g kg-1 seed) + Biofriendly Polymer (6g kg-1 seed) + Colourant + with or without thiamethoxam (3 kg-1 seed) recorded statistically higher yields with an increase of 15 % compared to the untreated control. This treatment also recorded less wilt incidence of post flowering stalk rot with a wilt reduction percentage upto 50% compared to untreated control. Pigeonpea seed treated with Trichoderma viride-TRIECO (2g)+ Bacillus megaterium - PHOSCO (2g)+ Rhizobium (4g) + Biofriendly polymer (6g) recorded high yield compared to untreated control even after one month of seed coating.

Biological seed coating is a fastest growing segment in the seed treatment. Biological agents can safely be delivered through coatings on to the seed surface with the help of an adjuvant.

Biological agents like Trichoderma viride, Pseudomonas fluorescens, Bacillus subtilis, Bacillus megaterium, Rhizobium leguminosarum showed compatibility with seed coating materials like biofriendly polymer, coloured polymers and thiamethoxame (insecticide).

Same treatment in pigeonpea recorded late wilt incidence i.e., after pod formation stage compared to early wilt incidence in untreated control at seedling stage.

Introduction

Biological seed coating is an ecological approach using selected fungal antagonists against the soil and seed-borne pathogens and it has a potential to provide an alternative to chemical control. Biological seed coating refers to the application of certain biological agents to the seed prior to sowing in order to suppress, control or repel pathogens, insects and other pests that attack seeds, seedlings or plants and its ranges from a basic dressing to coating and pelleting. Application of beneficial microorganisms to seeds is an efficient mechanism for placement of microbial inoculum into soil where they will be well positioned to colonize seedling roots and protect against soil-borne diseases and it also gives protection against oxidative stress induced by heavy metals. Soil application of Trichoderma viride + seed treatment shows minimum wilt incidence with maximum yield. The polymer acts as a protective cover for bioagents, helps in improving the shelf life and dust free seed. The biological seed treatment is low cost, alternative viable technology to chemical based plant protection and nutrition. Conventionally the seed treatment with bioagents is done a day before sowing as mostly on farms on the pretext that the bioagent will lose the viability during seed storage if the treatment is done during seed processing and packaging. Often the farmers fail to treat the seed with bioagents due to lack of knowledge and also proper adjuvant. It is a promising tool to deliver microbial inoculations into soil which enhances the nutrient use efficiency. The main constraint in biological seed inoculation is that it is to be done just one day before the sowing by demanding lot of attention from the farmer during the peak period of field preparation. Keeping this in view, seed technology research was carried out on the standardization of the Biological Seed Coating technology for five years.

biological agents to the seed prior to sowing in order to suppress, control or repel pathogens, insects and other pests that attack seeds, seedlings or plants and its ranges from a basic dressing to coating and pelleting.

Materials and Methods

The investigations on standardization of Biological Seed Coating Technology were being carried out from 2015-16 to 2019-20 in the Department of Seed Science and Technology, Seed Research and Technology Centre, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, Hyderabad, Telangana. Good quality freshly harvested seeds of maize (Kaveri 50; V-23 and DHM 117) and pigeonpea (LRG 41 and PRG 176) were used for these investigations. Biological agents like Trichoderma viride, Pseudomonas fluorescens, Rhizobium spp., Bacillu subtilis, Bacillus megaterium, Phosphorous solubilizing bacteria (PSB) were procured from different sources like Biofertilizer unit, PJTSAU; Agri Biotech Foundation (ABF), Rajendranagar, Ecosense laboratories, Mumbai. Biofriendly polymer was collected from Centor India, Hyderabad, Telangana and chemical protectants were also procured from the authorized dealers, Hyderabad.

Compatibility of seed coating materials and bioagents were studied using poisoned food technique and zone of inhibition techniques. Compatible seed coating materials and bioagents were used for biological seed coating at different recommended dosages. Uniformly coated seed was shade dried for 2 h. Treated seed was made into 3 replications and packed in sealed polythene bags and stored under ambient conditions.

The viability and shelf life of biological agents was evaluated using standard plate count agar method. One gram of treated seed samples were serially diluted and appropriate dilutions were plated on PDA medium (T. viride treated samples), King's B medium (P. fluorescens treated samples), Yeast extract mannitol agar medium (Rhizobium treated samples) or Pikovskaya medium (PSB treated samples). Three replications were maintained for each dilution plated. The plates were incubated for 2 days at 280C, following which the bacterial counts were taken. All fungal inoculated petriplates were incubated at 25±20C in a BOD incubator for 5 days following which the counts were taken. The standard germination and other seed quality tests were conducted as per International Seed Testing Association (ISTA) rules by adopting between paper method. Bioefficacy under wilt sick plots and field performance studies were carried out with one and 4 months old coated seed. The data recorded were analyzed statistically by adopting completely randomized design (CRD) for lab data and randomized block design (RBD) for field data and the standard error of difference was calculated at 5% probability level to compare the mean difference among the treatments. The data recorded as percentage were transformed to the respective angular (arc sin) values before subjecting them to statistical analysis.

Compatible seed coating materials and bioagents were used for biological seed coating at different recommended dosages. Uniformly coated seed was shade dried for 2 h.

Results and Discussion

In depth research has been taken up on the standardization of biological seed coating technology in the department of Seed science and technology over a period of time and addressed various gaps in the technology. The sequence of studies taken up and the results obtained were presented and discussed here in this section.

Standardization of adjuvants for biological seed coating, viability and shelflife of bioagents and seed quality and longevity in pigeonpea

Research on biological seed coating technology was initiated in the year 2015-16. Pigeonpea (LRG-41) seed was coated with four biological organisms like Trichoderma viride, Pseudomonas fluorescens, Rhizobium and Phosphorus Solubilizing Bacteria by using two adjuvants i.e., bio friendly polymer and sugar syrup. Treated seed was kept for six months storage in polythene covers. The viability and shelf life of biological agents were tested through Colony Forming Units for a storage period of six months. Among the adjuvants tested, bio-friendly polymer showed more viability and long shelf life for all the four biological agents compared to farmer practiced adjuvant, sugar syrup. Bio-friendly polymer recorded sufficient number of cfu in all the biological agents even after six months after storage (Figure 2) which were sufficient for colonization to give protection to the young seedlings against soil borne pathogens. With regard to the type of inoculation, biocontrol agent alone recorded more viability and longer shelf life compared to its co-inoculations with bio-fertilizers (Figure 1). After 6 months of storage, biologically coated seed with bio-friendly polymer recorded good seed longevity by recording high seed germination (Figure 3) and seedling vigour parameters (V. Jagadeesh, 2016).

Standardization of adjuvants for biological seed coating, viability and shelflife of bioagents and seed quality and longevity in pigeonpea

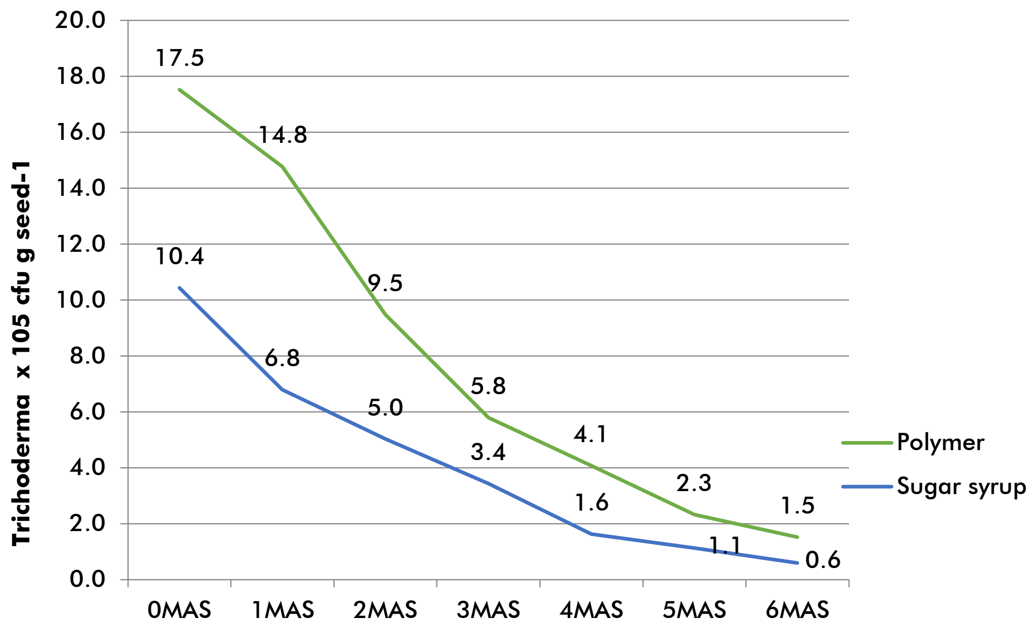

Figure 1: Effect of adjuvants on the viability and shelf life (CFU) of Trichoderma viride during storage of biologically coated seed of pigeonpe. (Note: MAS-Months After Storage)

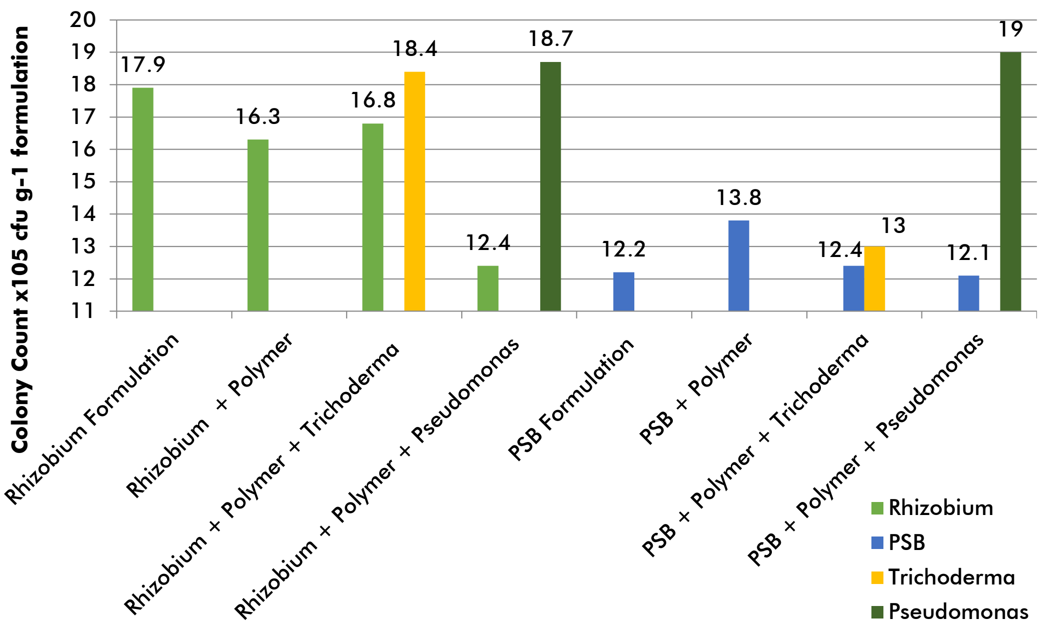

Figure 2. Effect of biofriendly polymer on the viability (CFU) of biofertilizers in the combined inoculations with bioprotectants (CD0.05 is 3.793 and 3.117 for the combinations of Rhizobium and Phosphorus Solubilizing Bacteria, respectively).

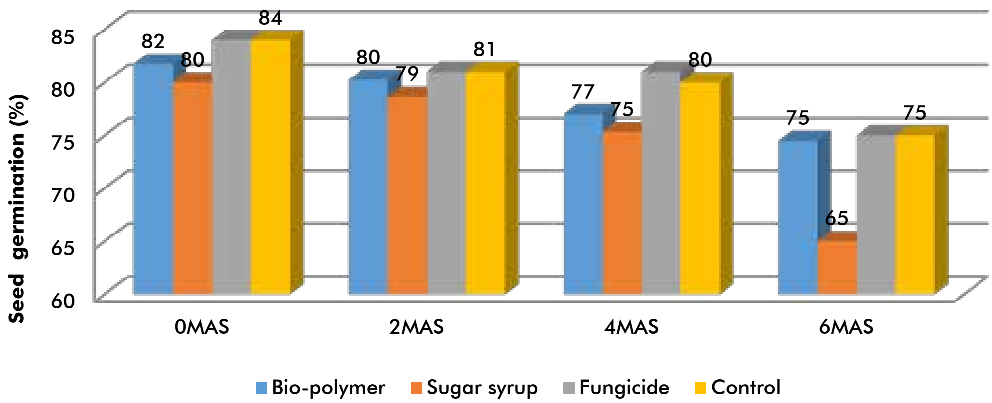

Figure 3: Effect of biological seed coating with Trichoderma viride on pigeonpe seed longevity and germination (%) (Note: MAS-Months After Storage)

Standardization of dosage of bioagents, viability and shelflife of bioagents, seed longevity and field performance of biologically coated maize

During 2nd year (2016-17), maize seed (V23) was coated with T. viride (4 or 2 g kg-1 seed) or Bacillus megaterium (4 or 2 g kg-1 seed) in various combinations using biofriendly polymer as an adjuvant. After 7 months, seeds coated with T. viride @ 4g Kg-1 seed recorded with average fungal colonies of 4.8 x 103 cfu/10 seeds and seeds coated with B. megaterium @ 4g Kg-1 seed with average bacterial colonies of 3.5 x 104 cfu/10 seeds. No decrease in the seed quality parameters of biologically coated seed of maize was observed even after 18 months of coating. Maize seed coated with either T. viride or B. megaterium @ 4gm/ Kg Seed + Thiamethoxam+ Biofriendly Polymer and T. viride + B. megaterium @ 2gm each/ Kg Seed + Thiamethoxam+ Biofriendly Polymer recorded high germination (93%), seedling quality parameters and seedling vigour, on par with untreated control (92%) at 18 months of treatment (Figure 4). Under field conditions, six months after storage, seed coated with T. viride + B. megaterium @ 2gm each/ Kg Seed + Thiamethoxam+ Biofriendly Polymer recorded comparatively more yield per hectare. Initial loadings per seed were ranged from 17 – 2.6 x 105 fungal cfu seed-1 and 26 – 8.3 x 106 bacterial cells seed-1. Colonies / cells of bioagents were recorded to be declined with advancement of seed storage period (O'Callaghan et al., 2006, O'Collagen 2016 and Jagadeesh., 2016). CFUs were recorded even 7 and 14 months after coatings (Table 1). More viability and long shelf life of bioagents were recorded in the consortia seed coatings at 2g each (T7) than individuals (Dr. P. Sujatha, 2017).

Maize seed coated with either T. viride or B. megaterium @ 4gm/ Kg Seed + Thiamethoxam+ Biofriendly Polymer and T. viride + B. megaterium @ 2gm each/ Kg Seed + Thiamethoxam+ Biofriendly Polymer recorded high germination (93%), seedling quality parameters and seedling vigour, on par with untreated control (92%) at 18 months of treatment (Figure 4).

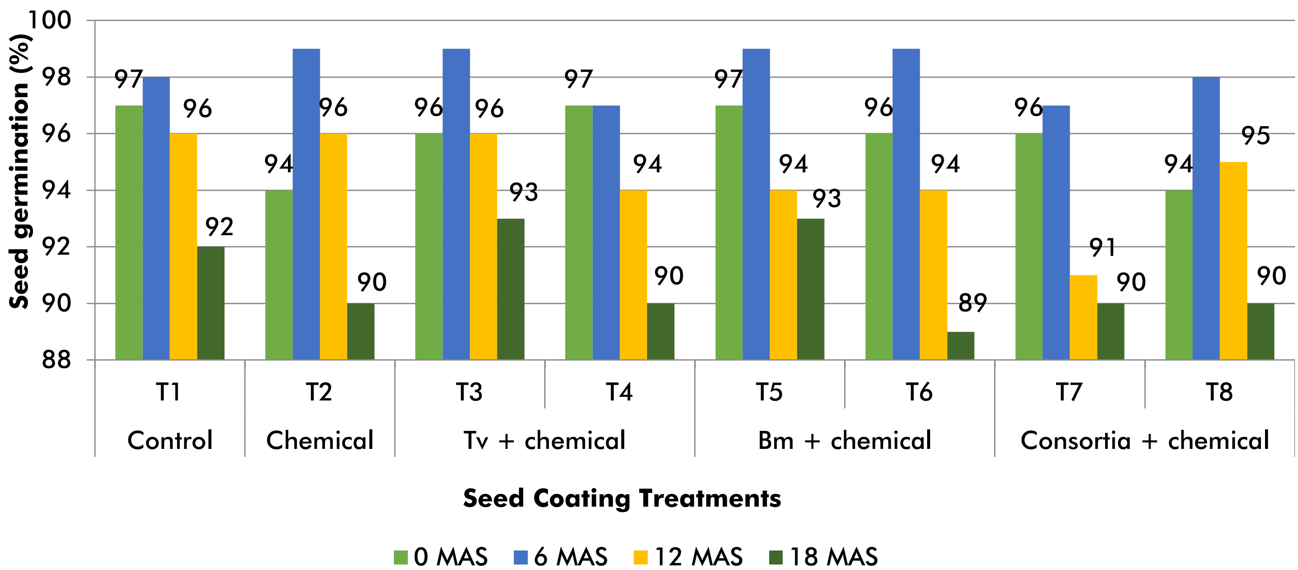

Figure 4: Maize seed coated with consortia (T7 & T8) recorded on par seed germination and longevity with that of chemical (T2) and untreated control (T1)

Table 1: Effect of biological seed coating on viability and shelflife of bioagents

Treatments		Average fungal count of T. viride (cfu/seed)			Average Bacterial count of B. megaterium (cfu/seed)		
		0MAS	7MAS	14 MAS	0MAS	7MAS	14 MAS
T1	Untreated control	-	-	-	-	-	-
T2	Thiamethoxam (3g kg^{-1} seed) + Metalaxyl (2g kg^{-1}) + Bio-polymer (4g kg^{-1})	-	-	-	-	-	-
T3	T. viride (4g kg^{-1}) + Thiamethoxam (3g kg^{-1}) + Bio-Polymer (4g kg^{-1})	9.3×10^5	15.0×10^2	62	-	-	-
T4	T. viride (2g kg^{-1}) + Thiamethoxam (3g kg^{-1}) + Bio-Polymer (4g kg-1)	2.6×10^5	6.4×10^2	54	-	-	-
T5	B. megaterium (4g kg^{-1}) + Thiamethoxam (3g kg^{-1}) + Bio-Polymer (4g kg^{-1})	-	-	-	26×10^6	7.8×10^3	1.9×10^2
T6	B. megaterium (2g kg^{-1}) + Thiamethoxam (3g kg^{-1}) + Bio-Polymer (4g kg^{-1})	-	-	-	22×10^6	5.9×10^3	1.3×10^2

Treatments		Average fungal count of T. viride (cfu/seed)			Average Bacterial count of B. megaterium (cfu/seed)		
		0MAS	7MAS	14 MAS	0MAS	7MAS	14 MAS
T7	T. viride & B. megaterium (each 2g kg-1)+ Thiamethoxam (3g kg-1) + Bio-Polymer (4g kg-1)	17.0×10^5	15.0×10^2	83	17×10^6	20.0×10^3	9.8×10^2
T8	T. viride & B. megaterium (each 1g kg-1) + Thiamethoxam (3g kg-1) + Bio-Polymer (4g kg-1)	8.3×10^5	9.5×10^2	45	8.3×10^6	4.7×10^3	4.3×10^2

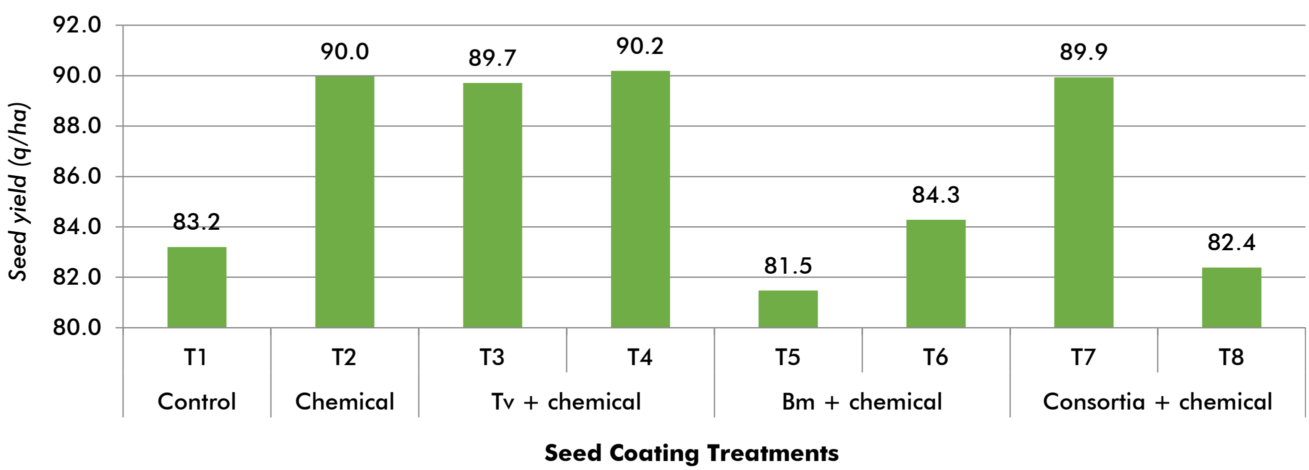

Figure 5: Seed coated with consortia (T7), T. viride+ chemical (T3 & T4) recorded on par seed yield with that of chemical (T2).

Studies on the compatibility, confirmation of viability and shelflife of bioagents, seed longevity, in-vitro and in-vivo efficacy of bioagents against test pathogen and field performance of biologically coated maize seed

During 3rd year (2017-18), continuation investigation titled "Studies on biological seed coating in Maize" was carried out by treating maize seed (DHM117) with T. viride, P. fluorescens and Bacillus subtilis using colourless biofriendly polymer. All bioagents showed highest compatibility with thiamethoxam (insecticide) and biofriendly polymer (adjuvant). With fungicides, bioagents showed some compatibility with metalaxy and incompatibility with sixer (Plate 1). Under invitro conditions, all bioagents showed effective inhibition of Macrophomina phaseolina (major causative organism of Post Flowering Stalk Rot in maize) (Plate 2). Scanning Electron Micrographs revealed the presence of biocontrol agents on the seed and root surfaces of maize even after four months of biological coating (Plate 3). Mycoparasitic and antagonistic activity of biocontrol agents against M. phaseolina was also determined through SEM. Biological seed coating showed a significant effect on maize seed quality and longevity even after 7 months of coating. Seed biologically coated with thiamethoxam @ 3 g kg-1 seed + metalaxyl @ 2 g kg-1 seed + bio friendly polymer @ 6 g kg -1 seed + P. fluorescens @ 10 g kg-1 seed + Bacillus subtilis @10 g kg -1 seed recorded good seed quality and longevity. Maize seed treated with thiamethoxam @ 3 g kg-1 seed + metalaxyl @ 2 g kg-1 seed + bio friendly polymer @ 6 g kg-1 seed + T. viride @ 5 g kg-1 seed + P. fluorescens @ 10 g kg-1 seed + B. subtilis @ 10 g kg-1 seed recorded high seed yield per plot (10.08 kg) compared to untreated control (9.0 kg). Maize seeds coated with T. viride + thiamethoxam + metalaxyl + biofriendly polymer recorded low disease score of 3.7 with highest efficacy compared to untreated control with 5.9 score (tooth pick method). Thus, from these findings, it is concluded that the maize seed coated with biocontrol agents, bio friendly polymer, compatible insecticides and fungicides retain its viability even up to 7 months of treatment and with less incidence of storage pests and diseases thereby improving the field performance of the crop (J. Sandhya Rani, 2018).

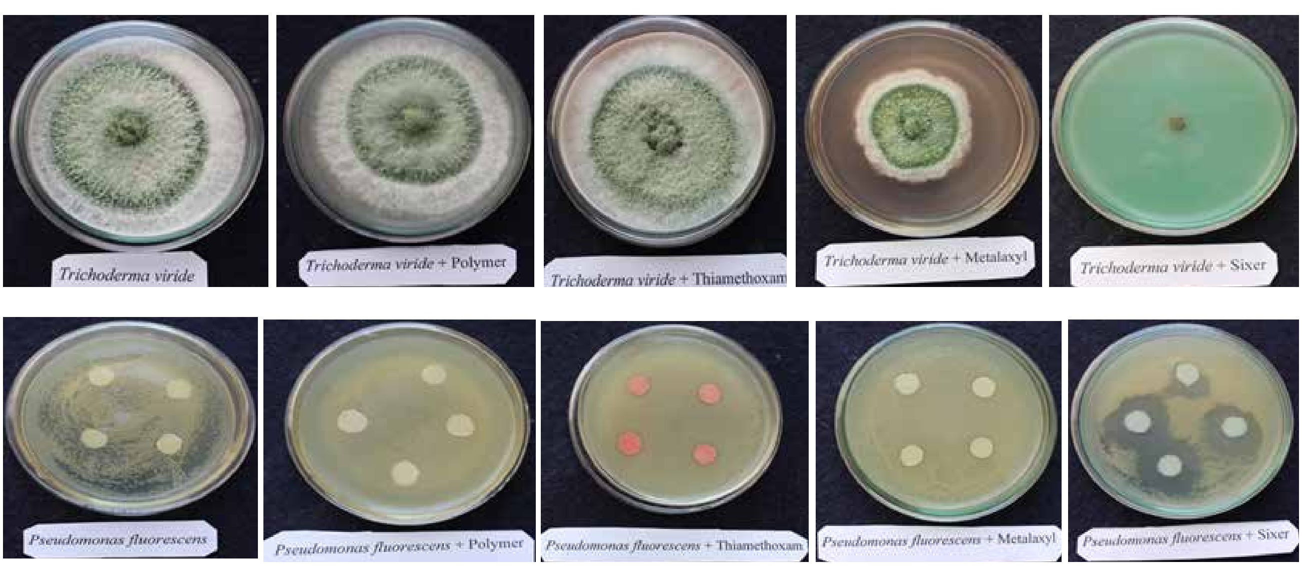

Plate 1. Trichoderma viride and Pseudomonas fluorescens showed compatibility with thiamethoxam (insecticide) and biofriendly polymer; partial compatibility with metalaxy (fungicide) and incompatibility with sixer (fungicide).

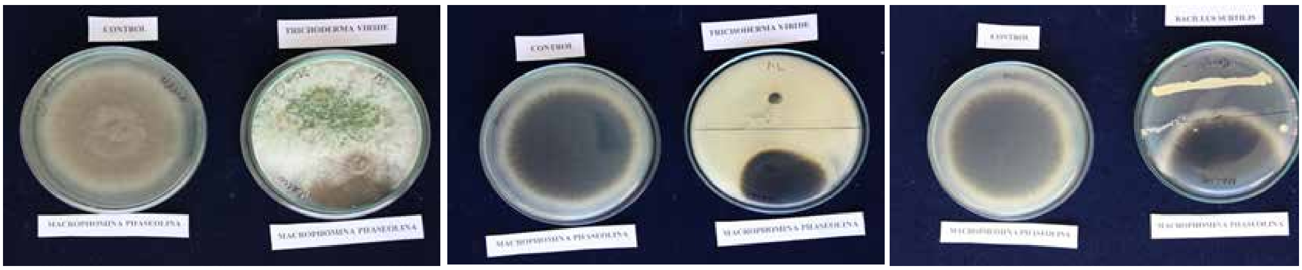

Plate 2. Bioefficacy of Trichoderma viride and Bacillus subtilis, which showed inhibition of Macrophomina phaseolina (major causative organism of Post Flowering Stalk Rot in maize), under invitro conditions

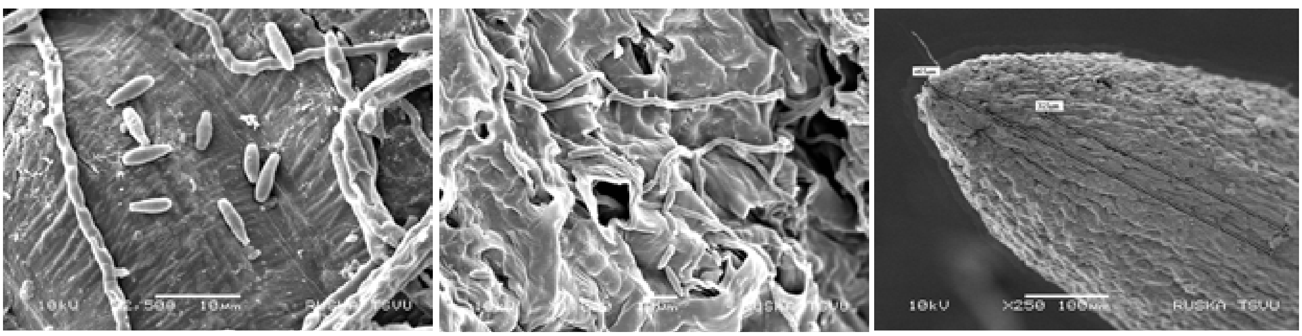

Plate 3: Scanning Electron Micrographs revealed the presence of biocontrol agents on seed and root surfaces of maize even after four months of biological coating. Seed and root surfaces of maize showing the presence of T. viride (Hyphae and conidia at x1000) and B. subtilis (bacterial cells at x250)

Studies on the compatibility, type of seed coating, period of storage after coating, seed longevity, in-vitro and in-vivo efficacy of bioagents against test pathogen and field performance of biologically coated pigeonpea seed

During 4th year (2018-19), the investigation titled "Studies on the effectiveness of biological seed coating on seed quality and field performance in Pigeonpea (Cajanus cajan L.) was carried out with T. viride, P. fluorescens, B. subtilis, R. leguminosarum and Beauveria brongniartii using deltamethrin (insecticide) and biofriendly polymer. All bioagents showed high compatibility with deltamethrin (insecticide) at 40 ppm and 4000 ppm. Under invitro conditions, all biological agents showed a significant inhibition of Fusarium udum by arresting its radial growth. Viability and shelflife of all bioagents both in the commercial bioformulations and on the surface of coated pigeonpea seed were observed to be decreased gradually from 0MAS to 4MAS under ambient storage conditions. Seed quality parameters of pigeonpea were gradually decreased with the increase in the storage period from 0MAT to 6MAT. Seeds coated with deltamethrin (insecticide) @ 0.04 g kg-1seed + T. viride @ 4 g kg-1 seed + P. fluorescens @ 4 g kg-1 seed + B. subtilis @ 4 g kg-1seed + Rhizobium @ 4 g kg-1seed + biofriendly polymer @ 4 g kg-1 seed recorded good seed quality and longevity after 6 months storage by showing more germination and seedling vigour. Under wilt sick field conditions, wilt incidence was observed to be increased with the increase in the crop growth period upto 120 days and from thereafter the disease showed no progression. Seeds treated with insecticide + bioagents + biofriendly polymer recorded lowest wilt incidence (22%) compared to untreated control (49 %). Yield attributing parameters and seed yield per hectare was recorded to be high (831.26 kg ha-1) in seeds treated with T. viride @ 4 g kg-1 seed + P. fluorescens @ 4 g kg-1seed + B. subtilis @ 4 g kg-1seed + Rhizobium @ 4 g kg-1seed + Deltamethrin @ 0.04 ml kg-1 seed+ Biofriendly polymer @ 3-4 g kg-1 seed (A. Akhil Reddy, 2019).

Confirmation studies on the bioefficacy of biologically coated maize and pigeonpea seed

During 5th year (2019-20), the confirmation studies on the bio-efficacy of biologically coated maize (Kaveri 50) and pigeonpea (PRG 176) seeds after one month of seed coating were carried out under the field conditions at wilt sick plot and management plots of the PJTSAU during both the seasons of Kharif, 2019 and Rabi, 2019-20. Maize (Kaveri 50) seed treated with T3 (Thiamethoxam (3 kg-1 seed) + Trichoderma viride (5g kg-1 seed) + Pseudomonas fluorescens (10g kg-1 seed) + Bacillus subtilis (10g kg-1 seed) + Biofriendly Polymer (6g kg-1 seed) + Colourant) followed by T4 recorded statistically more yields compared to untreated control (Table 2). These treatments recorded an yield increase of 15 % compared to the untreated control. These treatments also recorded less wilt incidence with a reduction percentage upto 50% when compared to untreated control in maize (Plate 4). Pigeonpea (PRG 176) seed treated (T4) with Trichoderma viride-TRIECO (2g)+ Bacillus megaterium - PHOSCO (2g)+ Rhizobium (4g) + Biofriendly polymer (6g) recorded more yield compared to untreated control even after one month of biological seed coating. Same treatment (T4) also performed better in wilt sick plot at RARS, Warangal by showing wilt incidence after pod formation stage compared to untreated control, which showed wilt incidence even at seedling stage (Plate 5) itself (Dr. P. Sujatha, 2019).

Treatments		Kharif, 2019			Rabi 2019-20		
		Yield (Kg / Ha)	Yield Increase over control (%)	Yield (Kg / Ha)	Yield Increase over control (%)	Wilt incidence (%)	Reduction in wilt incidence over control (%)
T1	Thiamethoxam (3 kg^{-1} seed) + Metalaxyl (2g kg^{-1} seed) + BF Polymer (6g kg^{-1} seed)	-	-	-	-	-	-
T2	Thiamethoxam (3 kg-1 seed) + Trichoderma viride (2g kg-1 seed) + Bacillus megaterium (2g kg-1 seed) + Biofriendly Polymer (6g kg-1 seed) + Colourant	3815	5.09	5970	4.34	17.04	47.29
T3	Trichoderma viride (5g kg-1 seed) + Pseudomonas fluorescens (10g kg-1 seed) + Bacillus subtilis (10g kg-1 seed) + Biofriendly Polymer (6g kg-1 seed) + Colourant + Thiamethoxam (3 kg-1 seed)	4222	16.31	6852	19.75	14.33	55.68
T4	Trichoderma viride (5g kg-1 seed) + Pseudomonas fluorescens (10g kg-1 seed) + Bacillus subtilis (10g kg-1 seed) + Biofriendly Polymer (6g kg-1 seed)	4074	12.23	6648	16.19	14.67	54.64
T5	Untreated Control	3620		3620	-	32.33	-
	Mean	3935	3935	6273		19.59	
	CD	578.001		942.629		5.304	
	CV	9.751		9.975		14.974	

Performance of biologically coated maize seed under wilt sick plot

Performance of untreated maize seed under wilt sick plot

Plate 4: Bioefficacy of biological Seed Coating Technology at 1 month after coating in maize

Pigeonpea wilt infection started after pod formation stage

Plate 5: Bioefficacy of biological Seed Coating Technology at 1 month after coating in pigeonpea

Studies on the compatibility of bioagents with colour polymers, confirmation of viability and shelflife of bioagents, seed longevity and field performance of biologically coated maize seed

During 5th year (2019-20), another simultaneous investigation was carried out to study the compatibility of bioagents with colour polymers available in the market. This investigation was carried to gain market acceptability of dark coloured biologically coated seed among the seed industry and farming community and to minimize the effect of dark colouration of biologically coated seed (because of charcoal which is used as a carrier of bioagent). And all polymers under test showed compatibility with the bioagents (Plate 6). Shelflife & viability of bioagents on the coated seed surface was studied in the pot culture experiment and these studies need to be confirmed on large scale. The effect of biological seed coating with coloured polymers on seed quality and longevity and the bioefficacy under field conditions were also studied (K. Arpitha, 2019-20).

Shelflife & viability of bioagents on the coated seed surface was studied in the pot culture experiment and these studies need to be confirmed on large scale.

Untreated maize seed

Chemical treatment- thiamethoxam+ metalaxyl


BSC – Solid bioformulations + colourless BF polymer


BSC – Solid bioformulations + Thiamethoxam+ colourless BF polymer


BSC - Solid bioformulations + colourant + colourless BF polymer


BSC - Liquid bioformulations+ colourant + colourless BF polymer


BSC- Liquid bioformulations Thiamethoxam+ colourless BF polymer + colourant


BSC - Liquid bioformulations+ Coloured Polymer

BSC- Liquid bioformulations Thiamethoxam+ Colour polymer 1

BSC- Liquid bioformulations Thiamethoxam+ Colour polymer 2

BSC- Liquid bioformulations Thiamethoxam+ Colour polymer 3

BSC- Liquid bioformulations Thiamethoxam+ Colour polymer 4

Plate 6. Biological seed coating of maize with coloured polymers and solid and liquid bioformulation

Studies on the effect of packaging material on the longevity of biologically coated seed of maize.

During 5th year (2019-20), another simultaneous investigation was carried out to study the effect of packaging material and genotypes response to the biological seed coating. In this investigation maize genotypes (2 inbreds and 2 hybrids) were coated with bioagents + insecticide+ Colourless biofriendly polymer+ colourant. Jute bags and polypropylene bags are used for storage under ambient conditions. Seeds treated with thiamethoxam (3g kg-1seed) + T. viride (2g kg-1seed) + B. megaterium (2g kg-1 seed) + Biofriendly polymer + Colourant of CI (6 g kg-1 seed) and stored in polypropylene bags recorded good longevity of maize seed at 8 months of storage. A significant variation was observed among the genotypes (T. Rambabu, 2019-20).

Conclusion

These findings may be helpful in the standardization of dry inoculated technology as a best alternative to on-farm biological seed treatments. Seed can be treated with bioagents well in advance of sowing i.e., after seed processing or before packaging. Biological seed coating with consortia of bioagents and in combination with compatible chemical seed protectants may be advisable for best results and long duration of protection during storage and at seedling stage.

Seed can be treated with bioagents well in advance of sowing i.e., after seed processing or before packaging.

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Importance of Seed Cleaning in SEED PROCESSING

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Introduction

When seed are brought in from the field, they contain undesirable materials such as pieces of stems, dust, weed seeds, other crop seed, and off-size, discolored, broken, and otherwise impaired units of the crop seed. Before the seed can be sold for planting through regular trade channels, enough of the undesirable materials must be removed to enable the seed to meet quality standards demanded by the farmers and required by law. Seed processing or seed conditioning is the preparation of harvested seed for marketing to farmers. The processes involved include drying, threshing, precleaning, cleaning, size grading, treating, quality testing, packaging and labelling.

Seed cleaning refers to the removal of any debris or low quality, infested or infected seeds and seeds of different species (weeds) that are foreign to the sample. Debris and damaged seeds can spread infection. Therefore, only good quality viable seeds should occupy space in the store and damaged or non-viable seeds should be destroyed to prevent the spread of infection.

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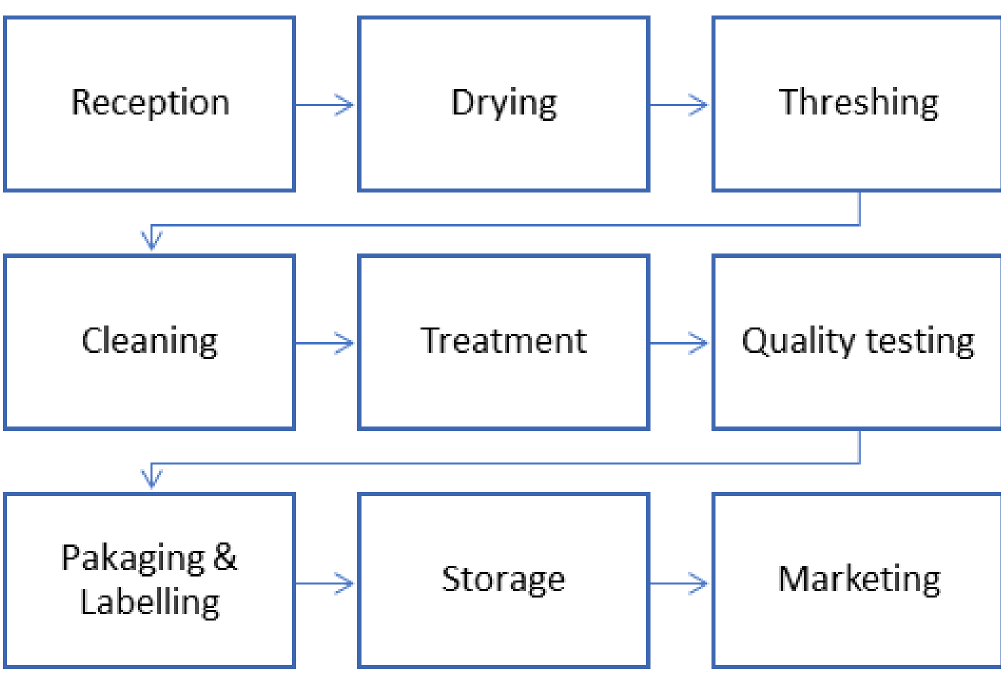
Seed Processing

Fig 1. Steps of Seed Processing



Seed processing or seed conditioning is the preparation of harvested seed for marketing to farmers. The processes involved include drying, threshing, precleaning, cleaning, size grading, treating, quality testing, packaging and labelling.

Seed lot contains the pure desired genotype seeds mixed with undesirable materials with some noticeable differences in terms of size (length, width, thickness), shape, weight/density, texture (rough, smooth, pointed) and colour. The seed-cleaning devices exploits these differences to separate the pure seed of desired genotype from the contaminants.

However, the seeds of the required product may not be uniform, including big and small, long and short seeds. Moreover, seeds and contaminants (e.g. weeds) without sufficiently different physical characteristics are not easily separated. No single machine is capable of separating seeds based on all the physical properties mentioned earlier. A variety of cleaning machines and equipment exist to separate seed according to specific physical characteristics.

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Threshing

Threshing is the separation of the seeds from spikes and straw. Traditionally, seeds are threshed manually or using animal power. Nowadays, mechanical threshers are also available. The principal operations in a seed-processing plant are reception; drying; cleaning and grading; treatment; and weighing, packaging and storage. When the seed lot is received it is marked clearly mentioning its seed lot number. A sample is drawn and dried to the correct moisture content and tested with a handheld electronic moisture meter.

Drying

Drying reduces the moisture content of the seed to the recommended levels for seed processing and storage. Drying seeds not only increases longevity in storage, but also prevents attack by pests and pathogens. Seed moisture content is key to the longevity of seed in storage. Seeds which are moist can be bruised and damaged during extraction. Seeds which are too dry are brittle and can easily crack.

If dried in the sun, the temperature should not exceed 35o C. If the temperature goes above that limit, it is necessary to cover it or move it to an area with a lower temperature. As the seed moisture content decreases, it reaches a point of equilibrium with the relative humidity. The rate at which this equilibrium is reached depends on the species, size and condition of the seed. The drying process is fast initially, and then gradually slows down. Once the seed is sufficiently dry, take samples to determine the moisture content using a hand-held moisture meter.

In tropical countries, seed drying is a major problem for farmers and enterprises, especially when the harvest coincides with wet weather. Simple mechanical dryers offer an effective solution. Unlike traditional sun drying, heated air drying permits the creation of uniform air conditions. Mechanical drying produces better quality seed than traditional sun drying and is, therefore, usually recommended to produce premium quality seed. Heated-air mechanical dryers normally dry seed in batches. A certain amount of seed is dried at a time, depending on the volume or holding capacity of the dryer. In batch drying, consider the loading and unloading time for each batch of seed to be dried. The most common static or fixed-bed dryers are flat-bed dryers. Lay the seed on a perforated screen, and force air up from below. The air fan is usually a simple axial flow fan powered by a diesel engine or electric motor. It may also be powered by kerosene burner, biomass stove or solar power. The air temperature is set according to the desired safe storage moisture content of the seed. Recirculating batch dryers can handle large amounts of seed in the peak season and produce high-quality grain. The most common version of a recirculating batch dryer is a self-contained unit comprising a tall vertical drying column around a central plenum chamber (for mixing); a fan and heater; and a central auger (for transporting the grain from the bottom to the top). Most dryers of this type are portable, easily transported from farm to farm.

Continuous drying means that the grain flows continuously through the dryer without stopping. Continuous-flow dryers are an extension of recirculating batch dryers. Indeed, the dryer has the same features as a mixed or recirculating dryer. However, it requires several buffer bins to hold the discharged seed. Continuous-flow drying is more common in large grain complexes. The system can handle a large quantity of grain and it offers greater flexibility. The continuous drying system has lower operating costs than batch drying. Furthermore, it produces a uniform grain moisture content and its drying capacity is higher than that of the mixing grain batch dryer.

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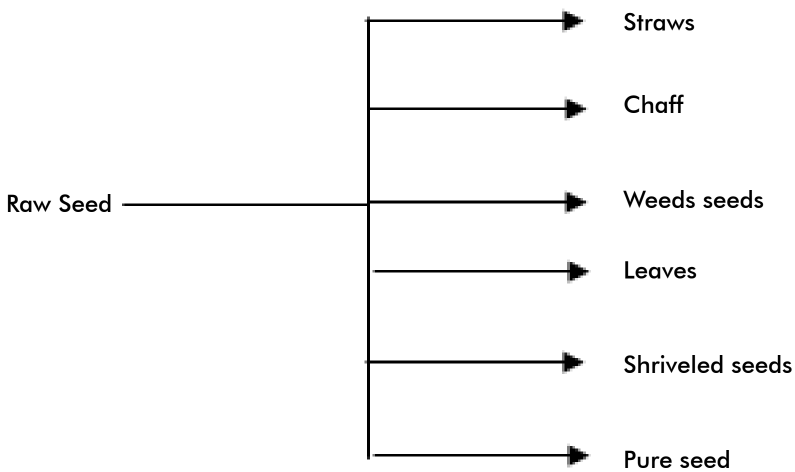
Seed Cleaning

Fig 2. Component of Raw Seed Lot



Seed cleaning refers to a process of removal of debris or any other unwanted material (straws, chaff, weed seeds, leaves, shriveled or sunken seeds) from the pure seed. Cleaning should be done in a way that causes the least damage to the sample and does not waste good seeds. Cleaning by hand is gentler and will do less damage to the seeds.

Steps Involved in Seed Cleaning

I. Pre-cleaning

Precleaning and preparation for conditioning and storage is a step that is too often neglected. Precleaning is most useful when there is a large amount of trash or green, wet material in the seed. Pre-cleaning is the preparation of the threshed seed for subsequent processing operations (e.g. drying and basic cleaning). It involves the rapid removal of impurities that are either very fine or very large compared to the seed, and the breakage or dispersal of materials in clusters. It may also include the removal of awns or beards – stiff bristles growing from the ear of cereal grains (e.g. wheat, barley, rye and many grasses). Pre-cleaning is not always necessary, for example, with certain hand-harvested and winnowed seeds. The objective is not to obtain quality seed, rather to facilitate subsequent operations.

> *The objective is not to obtain quality seed, rather to facilitate subsequent operations.*

Pre-cleaned seed flows better and improves the overall performance of the processing plant. It is important to dry and pre-clean seed as soon as it arrives at the processing plant. Precleaning involves winnowing, scalping and de-bearding.

II. Basic cleaning

Basic cleaning follows pre-cleaning and is the most important step in the seed cleaning process. It removes all the undesirable materials from the seed and improves the physical purity of the seed lot. For many seed lots, basic cleaning is the fundamental step towards achieving the finished product.

For many seed lots, basic cleaning is the fundamental step towards achieving the finished product.

Manual basic cleaning is only possible for very small quantities. For larger quantities, mechanical basic cleaning is necessary. The machine normally used for basic cleaning is the air-screen cleaner – the vital component in every seed-processing plant.

III. Air-Screen Cleaner

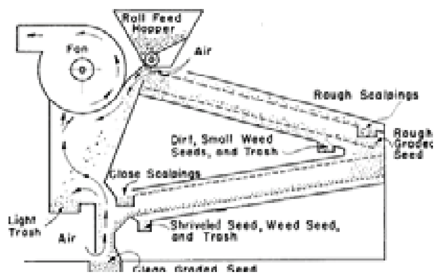
The air-screen cleaner is widely used and achieves a high level of physical purity. It is based on screens and a stream of air, and separates the seed lot into various quality fractions based on size (length, width and thickness), weight and density.

Two types of air cleaners mostly used in seed processing plants are:

i. Flat air-screen cleaners

The flat air-screen cleaner comprises the Inlet hopper situated on top of the cleaner to hold the incoming material. It provides a uniform and steady flow of raw seed into the cleaner. Feed roller mounted below the inlet hopper, it feeds the seed into the cleaner. The feed roller also shakes and mixes the incoming seed to ensure a gradual and uniform distribution of seed across the entire width of the uppermost screen. Screen boat is a compartment in which the screens are mounted. Screens with large holes are placed above, those with small holes below. The screen boat is connected to a drive mechanism, which provides an oscillating motion. Fan/dust collection system - a fan or central dust collection system sucks the dust-laden air generated by the seed flow. The air is sucked before or after screening or both. Discharge spout is situated at the end of each screen or set of screens, a discharge channel collects and delivers material by gravity or screw conveyor to an outlet. The material passes through the discharge spout and is collected in a bag. Flat screens are cheaper than cylindrical and are easier to clean between seed lots.

Fig 3. i. Flat air screen Cleaner ii. Process

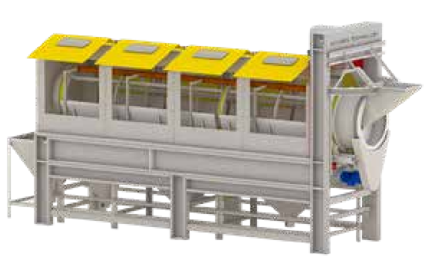


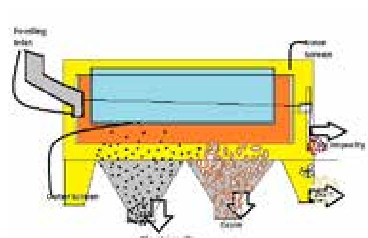
ii. Rotary air-screen cleaner

Cylindrical screens have the advantage over the flat air screen cleaner of a bigger throughput in kg/hour despite their smaller size. most widely used rotary air screen cleaner consists of an inclined cylinder made of a perforated steel screen, mounted on a shaft with suspension bearings; the steel drum rotates slowly round the shaft.

The cylindrical screen is divided into two sections: the section at the inlet has the smallest holes, the section at the outlet the largest. The entire cylinder is encased in steel. The inlet feed hopper is positioned above the cleaner. An outlet hopper is positioned below each section of the cylinder. The hopper for collecting the final cleaned product is connected either to the bagging system or to the next seed-cleaning and grading machine in the processing line. The rotary air-screen seed cleaner is connected to a fan or to the central dust collection system to provide the required stream of suction air.

Fig 4. i. Rotatory air screen cleaner ii. Process





The rotary air-screen seed cleaner is connected to a fan or to the central dust collection system to provide the required stream of suction air.

Although seed from the basic cleaning process is reasonably clean and high in physical purity, further processes of fine cleaning and grading may be necessary to raise the physical purity to the highest standard possible in the form of pure seed. Specialized machines separate the seeds according to density, length, width, thickness and shape. The machines commonly used for this purpose are indented cylinders and gravity separators, positioned after the air-screen cleaner. Additional machines have specific purposes, including the spiral separator, velvet roller, disc separator and electromagnetic separator.

IV. Gravity Separator

The gravity separator separates seeds of similar size but different specific weight (density). The gravity separator comes at the end of the seed-cleaning process, grading the cleaned seeds into quality fractions according to their specific weight. The gravity separator is a critical part of the processing line for high-value crops (e.g. vegetable seeds, grass seeds, legumes and pulses). On the other hand, for cereal seeds that have been through basic cleaning and fine cleaning with an indented cylinder, the gravity separator gives very little return on an eventual investment.

V. Spiral Separator

The spiral separator separates seeds according to their ability to roll. It was originally developed to remove unwanted particles from soybean seeds, but is now used for other crops with spherical seeds (e.g. brassicas - cabbage family).

VI. Disc separator

The disc separator - like the indented cylinder - separates seeds by length. It has a very high level of precision, but its throughput (kg/hour) is significantly lower than that of the indented cylinder.

VII. Electromagnetic separator

The electromagnetic separator detects differences in the evenness of the surface and the presence of gaps in the testa. It is a sophisticated item of equipment with high operating costs and is only used for very fine cleaning of expensive seed.

Specialized machines separate the seeds according to density, length, width, thickness and shape. The machines commonly used for this purpose are indented cylinders and gravity separators, positioned after the air-screen cleaner.

VIII. Colour sorting machine notes

The colour-sorting machine – or optical sorting machine – is a sophisticated piece of equipment that separates seeds according to colour or light reflection.

All possible contaminants have been removed and the seed has been graded; it is now ready for bagging. However, if required the seed lot can undergo the chemical treatment (fungicide or insecticide). Only properly labelled chemicals, specifically registered for seed treatment should be used. The chemical products not designed for seed treatment should be avoided. The appropriate treatments stick properly to the seed and impart a distinct colour indicating that the seed has been chemically treated.

Now the cleaned seed is packaged in a suitable material (e.g. polypropylene, paper or jute). Packages must be per unit weight (kg). The storage and sales packaging may be selected from a range of standard sizes and types available in the market.

There are a range of materials adopted for short-term seed storage, most of them porous. Inspect regularly for pest outbreaks or other forms of damage. Each material has advantages and disadvantages. The materials commonly used are Jute bags, Cotton Bags, Plastic bags, Paper bags, Cardboard boxes and polythene zip lock bags.

Sealed metal and glass containers are the most commonly used containers for long-term storage. It is imperative, in all cases, that containers are fitted with a rubber gasketed seal in good condition. They can protect seeds against humidity, insects, rodents and mechanical damage. For large quantities, metal cans fitted with rubber gasketed lids and pressure rings are ideal for storing big seeds (e.g. peas, beans and corn). Large jars with gasketed seals are also excellent; although breakable, glass allows the contents to be easily inspected for insect damage. Whereas, for small quantities, small sealed jars are ideal.

Once packaged, the bags are labelled to indicate that the seed has passed the quality control tests. For certified seed lots, the certification agency normally provides official labels. Alternatively, for non-certified seed or when the seed company is accredited for certification, it produces its own labels (TL seeds). Once packaged and labelled at the processing plant, the seed is transported directly for sale or held in storage until needed.

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Once cleaned (and treated if necessary), the seed is sent for packaging; it is placed in new bags, which are weighed and sewn. For seed not treated by an inline seed treater, a sachet containing the treatment chemical may be scattered on the seed in the weighed bag, which is then sewn. Bags are often preprinted with details indicating name of seed enterprise (and logo), seed class and net weight, plus a poison warning if the seed has been treated with chemical. Further information - variety, lot number and test date – is included on the label as appropriate.

Conclusion

Cleaning grains after harvest is important as it removes unwanted materials from the grain. Malformed, discolored, germinated, broken or moldy grains in seed lots can severely impact seed quality, viability and vigor.

A clean grain has a higher value than a grain that is contaminated with straw, chaff, weed seeds, soil, rubbish, and other non-grain materials. Grain cleaning improves the drying, the storability of grain, reduce dockage at time of milling, and improve milling output and quality. Seed cleaning also reduce damage by disease, and improve yields. Therefore, the cleaning process must be carried out with utmost care and precision. An experienced person may handle the equipment or else supervise the workers to maintain the seed lot quality before and after cleaning. Moreover, cleaning of equipment is equally necessary when handling multiple crop or various varieties of crop seeds alternatively in a processing plant to avoid any crop to crop or varieties mixture.

Grain cleaning improves the drying, the storability of grain, reduce dockage at time of milling, and improve milling output and quality. Seed cleaning also reduce damage by disease, and improve yields.

Criticalities of Accurate Temperature & Relative humidity percent measurement for GOOD STORAGE OF SEEDS

Gubba Prashanth

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As we all know Seed is life. This has to be preserved till the farmer sows it. in this journey the seed spends a lot of time in a Seed Cold Storage. When the seed is in the cold storage Accurate Temperature & RH measurement for Good Storage of Seeds is important and there are a lot of criticalities involved in this measurement. As per one of the Harrington rule "For every decrease of 1% seed moisture content, the life of the seed doubles. This rule is applicable when moisture content between 5 and 14%." Also "For every decrease of 5°C (10°F) in storage temperature the life of the seed doubles. This rule applies between 0°C to 50°C." This only indicates that few degrees variation of temperature and RH will bring in the variation in the life of the seed. So unless we know the correct temperature and RH the life of seed is at stake. Accurate measurement of temperature and RH is key. Few criticalities of Temperature and RH measurement are below

Sling type Psychrometer – 1 deg depression in wet bulb

A psychrometer is the simplest kind of hygrometer. A psychrometer is an instrument which measures the relative humidity in the atmosphere through the use of two thermometers:

1. a dry bulb thermometer, is used to measure the temperature by being exposed to the air.
2. a wet bulb thermometer, measures temperature by having the bulb dipped in water.

Relative humidity depends on temperature and the pressure of the system of interest. The same amount of water vapor results in higher relative humidity in cool air than warm air. So there are no units as such, but it's normally expressed as a %.

A wick wetted with water, when the psychrometer is slung around the wetted wick cools the wet bulb to measure the wet bulb temperature and the dry bulb measures the air temperature. Using a psychometric chart you find where the measured dry bulb temperature line and the measured wet bulb temperature line

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intersect and read the line of relative humidity at that point on the chart. Percent humidity lines are ploted on the psychometric chart for each increment of relative humidity currersponding to a wet and dry bulb temperature. The depression i.e the difference in dry bulb temperature and wet bulb temperature determines the Relative Humidity %. Wrong measurement here brings a big variation in RH%. A 1 degree more depression means almost 5% lower RH. Here is an example.

Dry Bulb Temperature – Farhenheit	Wet Bulb Temperature - Farhenheit	Depression	RH%
55 Deg F	45 Deg F	10	43.50%
55 Deg F	46 Deg F	9	48.70%

In this above example just a 1 deg variation in the depression brings in a variation of 5.2% RH. Which can bring in a huge difference in the life of seed. Hence accurate measurement becomes super critical.

Calibration of Digital ThermoHygrometer

As we all know a digital thermohygrometer measures the temperature and Relative humidity. As we have seen earlier a very delicate relation exists between temperature and RH . Hence the accurate measurement of temperature of temperature an RH becomes even more critical. Thermo-hygrometer has a sensor that can degrade and drift anytime so a regular calibration must be applied. Calibration of the Digital ThermoHygrometer is important. To add to it not just calibration but Good calibration becomes very important. There are numerous calibration companies round the corner who will be more than willing to do for a few bucks less. However accurate calibration is important. Calibration done by NABL accredited lab gives an assurance that the temperature and RH measured is accurate. This assurance is not just for the person managing the cold room but also may be required by law or company policy to provide documentary evidence that your thermohygrometers are accurate at regular intervals, such as every year

Placement of Data Logger

We all want to know in what temperature and RH we are storing our seed. For this we place Data loggers in our cold room/cold storage. However accurate placement of data logger is important to know the right temperature and RH. For the

Thermo-hygrometer has a sensor that can degrade and drift anytime so a regular calibration must be applied. Calibration of the Digital Thermo Hygrometer is important.

practical reasons however good the cold storage is designed there WILL be variations in temperature and RH within the cold storage i.e. with the chamber. However good designed cold storage has lesser variations. Now, when we want to know the temperature in the cold storage we should be knowing the worst conditions. Temperature mapping comes into place here. Temperature Mapping is the process of recording and mapping the temperature in a 3 dimensional space. The purpose of temperature mapping is to ensure that all areas of the process equipment or storage area achieve the required temperature. The outcome of the test is a temperature map defining the cold spot of the process equipment or storage area. There's increased emphasis by regulators on compliance with GMP requirements for controlled temperature storage requirements.

After determining the hot spot in the cold storage the data logger is placed in the hot spot and thus we are assured that the temperature in the rest of cold storage is only lesser and not higher than what is mentioned in the data logger. (the details of how temperature mapping is done – may be in some other article ☺)

Altitude of a place

We all have been reading and talking about that the dry bulb temperature and wet bulb temperature determines the RH%. But there is also one more factor that determines the Relative Humidity %. That is the altitude of the place. As we go higher and higher the capacity of the air to hold moisture reduces and hence the RH% increases as we go higher and higher. With a certain dry bulb and wet bulb the RH% will be different in Chennai and in Hyderabad. Here is an example.

City	Altitude (in Feet)	Dry Bulb Temperature - Farhenheit	Wet Bulb Temperature - Farhenheit	RH%
Hyderabad	1788	55 Deg F	45 Deg F	45.90%
Chennai	22	55 Deg F	45 Deg F	44.40%

Hence while measuring the RH% the altitude of the city the cold storage is also should be considered.

The above are the few critical details by which accurate temperature & RH can be measured. Step1 for Good preservation begins from accurate measurement. And when it comes to measurement of temperature and RH , God lies in the details.

Seed Conditioning and Seed Enhancement in MILLETS



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Seed Conditioning

The process of removing unwanted materials such as trash, weeds, leaves, other crop seeds and insects etc from a seed lot along with overall improvement of seed quality, is known as seed conditioning or seed processing. It is the complete procedure which utilized all the technologies such as drying, threshing, pre-cleaning, cleaning, size grading, treating, quality testing, packaging and labeling in making high quality seed of improved varieties available to the farmers with minimum adulteration. Seed conditioning assure maximum quality seed as if seed is not conditioned and handled properly, all efforts of a plant breeder in varietal development and seed production can be lost. The ultimate goal of seed conditioning is to obtain the maximum percentage of pure crop seed with maximum germination potential, thereby seed enhancement.

Seeds can be separated by mechanical means only if they differ in some physical characteristics such as size (length, width, thickness), shape, weight/density, Surface texture (rough, smooth, pointed) surface color and also affinity for specific liquids and electrical properties etc. that can be detected by a mechanical or electrical process. Thus, the seed conditioner uses differences in physical characteristics of the seed crop being cleaned and those of seeds of other crops and weeds as well as inert matter.

Basic steps involved in seed conditioning/processing are drying (air drying, sun drying and mechanical seed drying), cleaning (pre-cleaning, basic cleaning and fine cleaning or grading), weighing, packaging, storage and labeling.

The ultimate goal of seed conditioning is to obtain the maximum percentage of pure crop seed with maximum germination potential, thereby seed enhancement.

Seed Conditioning in Millets

Sorghum

Seed processing is an integral part of Sorghum seed production which follow the steps such as drying, cleaning, grading, treating, and bagging. Optimum moisture should be about 20 per cent at harvest to minimize harvest losses and drying expense (Sumner, 2017). Sorghum stalks contain more moisture and are more likely to be chopped up and carried with seed. Seed properly threshed cleaned to the desired purity on the air screen cleaner. However, the gravity separator is commonly used to remove light materials. The threshed seeds should be physically pure by removing weed seeds, disease and pest infested seed, other crop seed, other cultivar seed, undesirable seed, and damaged seeds.

Drying

Sorghum has more trash mixed in the grains than other common crops. Pieces of green stems and foliage often mix in with the grains. This trash is difficult to remove before drying but can cause a fire hazard in dryers and offers resistance to air movement. Trash is usually removed from the grains by sifting through a screen or sieve. The seed fall through while trash remains. By rotary screens, the grain falls through and trash is retained but most rotary drum cleaners are designed to retain the seeds and drop the fines.

Seeds contain varying amounts of moisture at harvest, and if they are to be stored for subsequent planting it is essential that their moisture content is reduced to a safe level. Sorghum seeds should be dried to 10-11 per cent moisture content to avoid the multiplication of insect during storage. In sorghum, proper sun drying of ear heads is essential to bring down the seed moisture to desirable level to avoid seed deterioration. To dry bulk quantities of seeds mechanical seed dryer can be used. Maximum recommended air temperature for seed drying is 40° C, if seed moisture is more than 18 per cent, maximum recommended drying temperature is 32° C and if lower than 18 per cent, 40° C is the temperature for drying. The screen of dryer should not be finer than ¼ inch mesh or air movement may be restricted (Sumner, 2017). Dryers do not force air through grain sorghum as easily as through bold seeded cereals like corn because the smaller grains leave less space for air movement, the moisture content is usually high and the resistance to air flow is extremely high. As a result, grain sorghum dries slowly as compared to bold seed. The recommended air flow rates for drying sorghum are 0.02 m3/s per m3 of sorghum at 14 per cent moisture content to 0.04 m3/s per m3 of sorghum at 20 per cent moisture content (McFarlane et al., 1995).

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Seed cleaning and upgrading

In order to maintain the physical purity to the required standards seed cleaning is the essential step to separate the inert matter, weed seed, other crop/variety seed, disease and pest infested seed and any other undesirable contaminants. Sorghum seed cleaning and upgrading is mainly based on physical differences in seed volume, test weight and density. The sieve aperture sizes of top and bottom screens of air screen cleaner differ with genotypes. Generally the top screen has holes measuring 12/64" or 4.75mm with round holes and the bottom screen at 9/64"or 3.5mm with round holes (Tonapi et al., 2015). The specific gravity separator helps in upgrading the quality of seeds by rejecting the seed that is inferior in specific gravity.

Seed treatment and packing

Seed treatment refers to the application of fungicides, insecticides, or a combination of both to disinfect the seed from seed borne pathogens and to protect from soil borne organisms. Sorghum seed after seed treatment can be protected from systemic pathogens like loose smut and head smut and non-systemic pathogens like Helminthosporium blight, Fusarium and bacterial blights. Seed treatment also provides protection against storage pests (rice weevil) and shoot fly. Processed seed can be packed in cloth bags or poly lined bags at the rate of 3-4kg per bag, sewed with proper label of particular seed class and should be sealed with lead seal.

Seed quality control

Seed quality in India is legally controlled by the Seed Act, 1966. According to this Act all the seeds of notified varieties/ kinds when sold to farmers must meet the minimum standards of germination and physical purity. The seed should be packed in a suitable container and a label has to be affixed on the container. Information about germination, physical purity, variety, date of test, name of the seed producer has to be given on the label. The germination as given on the label is valid for eight months and after which it has to be revalidated for a subsequent period of four months after retest. Seed certification is the process designed to secure, maintain and make available high quality seed and propagating material of superior crop plant varieties, so grown and distributed as to ensure desirable standards of genetic identity, physical purity and other quality attributes. Certification is performed in five phases.

1. Verification of land requirements
2. Verification of seed source
3. Inspection of the seed crop in the field

The specific gravity separator helps in upgrading the quality of seeds by rejecting the seed that is inferior in specific gravity.

4. Inspection and testing of each lot and seed sample during the processing and bagging
5. Tagging, labeling and sealing to identify the seed

Pearl millet

Cleaning

Seed is passed through an air screen cleaner to remove inert material. Precautions have to be taken to ensure that machine is cleaned before using, desired screen is selected and samples are taken to assure that seeds are well cleaned. Threshed and cleaned seeds are graded using round perforated metal sieve of 4/64" size OSAW cleaner cum grader (Yadav et al., 2015).

De-stoning

During this, heavy impurities, such as stones, metallic particles etc. are separated from the seed. Gravity separators are used for grading of seeds to the highest standards of physical purity. Near-size grains are separated according to the differences in their specific weight. It also helps in removing damaged seeds and premature light weight seeds.

Chemical Treatment

Seed is treated with suitable chemicals to protect it from pests and diseases. Calibration is important for uniform seed coating. Slurry volume and dump speed are calculated for uniform coating. Seed is treated with metalaxyl 35 per cent WS at the rate of 2g a.i./kg seed for controlling downy mildew when the seed is used for planting. Delta-methrine at the rate of 0.04 g/kg seed is used for controlling stored pests (Yadav et al., 2015). Care should be taken in metalaxyl treatment of seed that is likely to be stored at room temperature for a longer time as metalaxyl treated seed stored at 40°C has been reported to show phytotoxic effects (Thakur et al., 2011).

Packing and labeling

Care is taken to ensure that each primary seed bag contains the proper quantity of seed, is sealed properly and final seed moisture does not exceed 12 per cent. The samples are again tested for warm germination test and accelerated aging test. Samples are taken during bagging to ensure that the seed meets

Seed is treated with suitable chemicals to protect it from pests and diseases. Calibration is important for uniform seed coating.

quality assurance standards. Information on the label should be as per country seed laws. Pearl millet bag size in India is usually of 1.5 kg and 3.0 kg. Label on each bag specifies name of crop and variety, seed class, seed lot number, year and date of production, expiry date of validity, germination percentage and seed purity (Yadav et al., 2012).

Storage

Storage conditions for nucleus seed include temperature of 4°C and relative humidity of 20 percent as the seed is stored for use in next few seasons. For breeder seed, temperature is 10°C and relative humidity of 20 percent. Foundation and certified seeds are stored at room temperature. For controlling storage insect-pests, fumigation is done. The cleaned and graded seeds can be stored up to 12 months with proper pre-storage treatment.

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Small millets

(Finger millet, Foxtail millet, Little millet, Kodo millet, Barnyard Millet and Proso millet)

Physiologically mature plants are either harvested intact with ear-heads or ear-heads alone. The ear-heads are dried before threshing and threshed by stone roller or trampling under the feet of bullocks. While in Proso millet ripening is not uniform throughout the panicle as the seeds in the upper portion of the panicle are ripe while the lower seeds are still green. These are harvested and swathing be done until most of the panicle has lost its green color.

Seed cleaning

Traditionally there are two techniques of cleaning-

Winnowing: In this process approximately 2 to 3 kg of threshed millet grains are placed on a flat reed or raffia-woven basket and winnowed by up and down strokes so that the grains are thrown up in the air and allowed to fall back onto the basket. During this, the sand and other light contaminants are separated to the front of the basket from where they are thrown off. The process is labourious, and time consuming, and may take up to 1 hour to clean 1 bag of 100 kg.

Aspiration: In this process the difference in densities between the good millet grains and contaminants is exploited to separate the contaminants from grains. About 10 kg of threshed millet grains are placed in a tin or basket and poured from above the head to fall on to the ground. The separation effect is best obtained when it is slightly windy, so that the wind current blows the light contaminants from the relatively heavy grains (Kajuna, 2001). This method is much faster than the traditional winnowing as four to five bags may be winnowed in one hour. However the method is not effective in separating sand, stone and metal contaminants which are as heavy as the millet grains.

Apart from these two techniques screening is done, where a set of sieves is used to separate abnormally small grains/ broken seed pieces or sand particles from the good ones.

Drying and Storage

The threshed and clean millet grains should be dried under the sun to attain a safe moisture level of 12 per cent. Care should be taken to avoid mechanical injury and contamination to the seeds while drying. Apart from the traditional sun drying, unheated air drying could be employed. This is a simple method to operate, and requires minimum attention to achieve uniform drying (McFarlane et al., 1995). However, unheated air drying is weather dependent, and in case of prolonged wet conditions with high relative humidity, the drying process may take a long time. In such circumstances, one may therefore, have to select the airflow rate very carefully to optimize the drying process.

Most millet has excellent storage properties and can be kept for up to 4-5 years in simple storage facilities such as traditional granaries as the seeds are protected from insect attack by the hard hull covering the endosperm (FAO and ICRISAT, 1996). After drying and threshing, millets may be stored as loose grain in bags or in loose containers (Kanuja, 2001).

However, the essential pre-requisites for storage of millets are the same as those for other grains.

- Major challenges in small millet seed processing are:
  - The grains are very small in size.
  - Variability in seed due to variable cultivation practices and micro climatic conditions among seed production regions.

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- The processing machines currently used for small millets processing are improvised form of paddy processing machines. These remove bran containing fibers, minerals and many other nutrients thereby reducing the nutrition of small millets.
- These machines as large scale mills are available only in some part of the country so resulted in movement of small millets away from the production areas.
- With existing machinery there is lower head rice recovery, it is very difficult to remove extraneous matter and to separate hulled and un-hulled grains. So there is urgent need to develop appropriate dehuller models.
- There is little or no local processing infrastructure in the villages which needs to be developed.

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DRY CHAIN CONCEPT - Seed Drying and Storage

Making the Difference in Food Security

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What is the biggest and unavoidable cost for seed companies?

Personnel? R&D? Travel? Legal?

NO!

It is …

INVENTORY WRITE-OFF!!!

Seed companies destroy their inventory between 25-30% each year, just because the seed is obsolete or more often, unsuitable for sales! Seed is a living organism. It breathes, it catches diseases, it ages, it dies….

How can we keep it alive and in good shape as long as possible? How can we identify seed that will deteriorate faster? And why? How can we minimize further deterioration and slow down the aging? How can we save the good seeds out of a bad lot?

To know the answers for above queries…follow the sequential concepts, understand clearly and adopt the best methods as per your seed requirement…

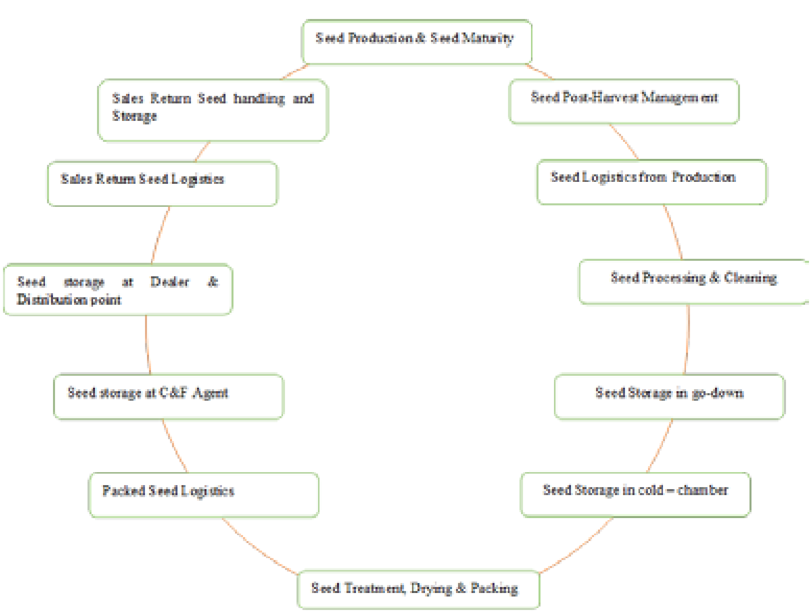
The following processes are crucial in managing the seed quality at different stages in Seed industry…

I. **Seed Production & Seed Harvesting Time:** Apart from standard procedures of selection of good quality foundation seeds, soil preparation and package of practices, identification of right physiological maturity and harvesting at right time to get high quality seeds in terms of good germination, high vigour and better storability properties. Once high-quality seeds are harvested at production further protecting and controlling the seeds quality will become easy. As shown in below picture, If seed harvesting is done once seed attains the viability, vigour and longevity capabilities, seed will have good germination, high vigour and long term storability. So harvesting time is crucial for seed longevity.

Selection of good quality foundation seeds, soil preparation and package of practices, identification of right physiological maturity and harvesting at right time to get high quality seeds in terms of good germination, high vigour and better storability properties.

Quality Factors develop during Seed maturity

II. Post-Harvest Management: Immediate drying of seeds to minimum storage moisture, its methodology and its duration after harvesting plays another key role in further seed quality management including storability. Seed undergoes following different post – harvest processes till packed seeds distribution to farmers as well as sales returns and management of sales returns seeds for further season supply to farmers. If seed moisture, storage temperature and RH are maintained properly, seed could be sold until its maximum life potential.



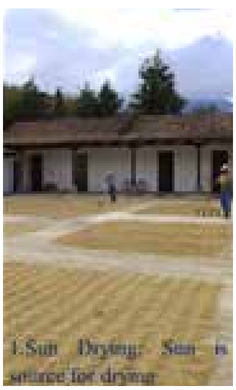
Immediate drying of seeds to minimum storage moisture, its methodology and its duration after harvesting plays another key role in further seed quality management including storability.

What is drying?

The process of elimination of moisture from the seed is called Seed drying. ... Seed drying also permits early harvesting, long term storage of seeds, more efficient use of land and manpower, the use of plant stalks as green fodder and production of high-quality seed.

Drying Methods: Classical Methods

1. Sun Drying

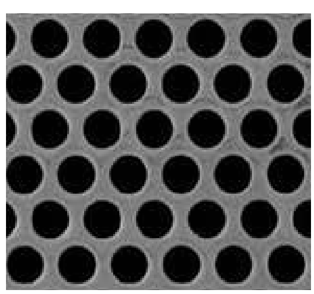


2. Shade Drying

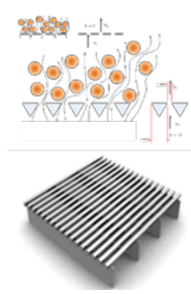
3. Static Drying System

4. Fluidized bed drying systems

Mesh type surface



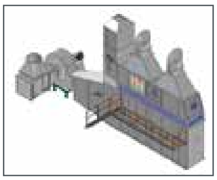
Perforated Plate type surface



Triangular type surface

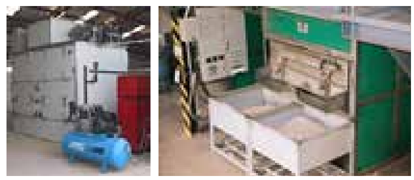
Seed drying also permits early harvesting, long term storage of seeds, more efficient use of land and manpower, the use of plant stalks as green fodder and production of highquality seed.

5. Continuous drying systems



6. Silo-Drying

7. Batch Drying Systems



8. Hermetic Containers & Packaging

Save Grain bags or PICS bags

Plastic or Metal Bins

Super bags GrainPro, Inc

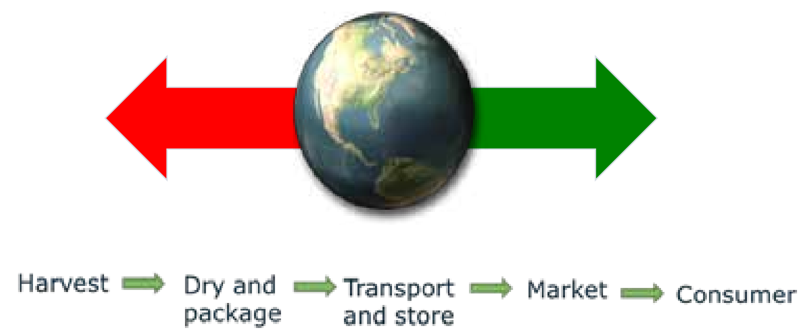
The major cause of postharvest food loss in humid regions is the inability to adequately dry and store commodities.

- High humidity is the core problem in tropical regions.
- High humidity speeds deterioration and enables growth of fungi and insects.
- Air-drying is unable to sufficiently dry commodities in humid regions.

The COLD CHAIN is a well-known principle in postharvest handling of fresh produce

Harvest → Cool → Refrigerated transport and storage → Market → Consumer

Practiced routinely on a worldwide scale with enormous impacts and proven results. However, it requires large infrastructural investment and continuous energy input to maintain refrigerated transport and storage facilities.



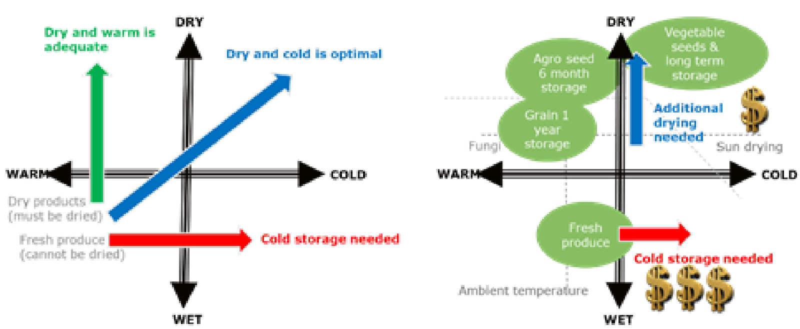
The DRY CHAIN as a concept is essentially unrecognized as a postharvest strategy.

Implementing the dry chain has a greater potential impact than the cold chain, with minimal infrastructure and no energy inputs after initial drying.

The Dry Chain Concept:

A storage matrix for seed and food products:

- Fresh produce must remain hydrated
  - o Cooling is required to extend life and prevent spoilage
  - o Utilize the cold chain
- Dry products must be dried to safe levels
- Storing cold after drying is optimal, but is not essential for medium term storage
- Utilize the dry chain



An economic map for each product

Concept of a total chain map

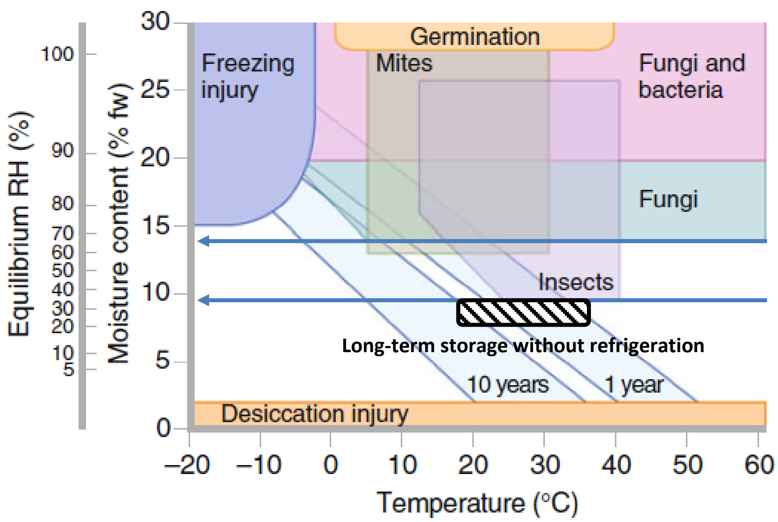
- Depending on product
- Depending on goal
- Depending on area
- Depending on availability of technology

Implementing the correct storage conditions based on the specific needs of the product and the technologies available

1. Maximum sun drying is often insufficient for storage
2. Sun drying is not possible during rainy season
3. Losses due to rodents, insects and birds
4. Deterioration of quality and nutritional value
5. Fungal infections & mycotoxins, health risks
6. Humidity has a negative impact on temperature tolerance

The Roberts graph – renewed:

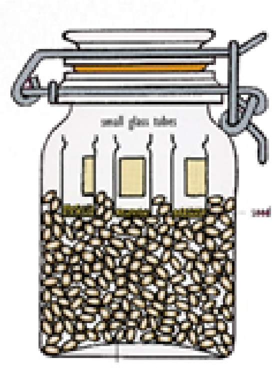
Roberts EH (1972) Viability of Seeds. Chapman and Hall Ltd., Syracuse, NY, pp 14-58.



Water absorbents:

Is a separate talk but can go from very old and simple systems to very advanced new ways of using absorbents for drying purpose?

1. Often used as tool for air conditioning (indirect way)
2. Roasted Rice: A "natural" desiccant



Seed can be dried in a Kilner jar

3. Silica Gel: A widely used system (often as a one-time-use system

4. Aluminum oxide

5. Molecular sieve

6. Drying Beads®:

Drying for the 21st century in a fast, economic, controlled and mobile system

Centor India, Hyderabad is offering an exclusive, fast, simple, inexpensive, easy and highly effective drying technology to Indian Seed Industry to dry and store high value seeds and other Agro products by controlling moisture content, the major parameter for seed storage and seed quality. Drying Beads give a fast and easy way for drying the seeds and, if stored properly, increase the shelf life of your seed tremendously. These beads increase the quality of the dried and stored seeds in a very efficient and cost-effective way.

Seed storage can be a major problem particularly for countries that are located in the tropics, where there is a combination of high temperature and high relative humidity which causes rapid deterioration of seed quality. In South Asia, seeds harvested before or during the monsoon season need to be dried and stored until the next planting season. The relative humidity of the air for most of the period between harvest and planting often exceeds 75% and temperatures remain above 30°C, causing seeds to deteriorate rapidly. Seeds absorb water from the ambient air when they are stored in humid environments and lose water when stored in low relative humidity. Generally speaking, a seed's longevity is reduced by approximately half for every 1% increase in seed moisture content (water content as a percent of fresh weight) or 5°C increase in temperature, and the effects are additive. Thus, seeds stored at 10% moisture content and 30°C will last only one-quarter as long as seeds stored at 9% moisture content and 25°C. This principle implies that seed storage life can be enhanced considerably by lowering both moisture and temperature. However, moisture content is the key factor that can be lowered for successful seed storage in tropical countries. Cold storage can be expensive and difficult to maintain. In addition, seeds that are dried to low moisture contents are more tolerant of storage at warm temperatures. However, even prolonged sun drying in high humidity cannot reduce seed moisture content to the levels low enough to assure long-term viability. These problems can be overcome by drying seeds to low moisture contents using inexpensive hermetic (sealed) containers and drying beads, a recently developed desiccant technology. Using drying beads, seeds can be quickly and efficiently dried to safe storage moisture contents, and

Seeds absorb water from the ambient air when they are stored in humid environments and lose water when stored in low relative humidity. Generally speaking, a seed's longevity is reduced by approximately half for every 1% increase in seed moisture content (water content as a percent of fresh weight) or 5°C increase in temperature, and the effects are additive.

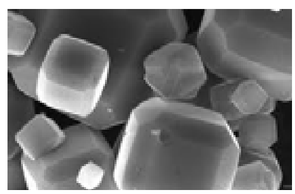
storing seeds in hermetic containers not only maintains low moisture contents, it also prevents losses to rodents, insects and molds. Seed desiccant drying beads provide a simple, inexpensive and reusable method for seed drying in humid climates.

What are drying Beads?

Drying beads (Zeolite Beads) are crystalline type with clay, so indestructible and have precise pores (< 3 A0) to absorb only water molecule. Drying beads have 30% water absorbing capacity, thermally & mechanically stable, non-toxic & food grade.

Drying Beads

Specific Pore Size (<3A0) for Water



Crystalline Structure

Drying beads are modified ceramic materials that specifically absorb and hold water molecules very tightly in their microscopic pores. The beads will continue to absorb water until all of their pores are filled, up to 20 to 25% of their initial weight. When placed in an enclosed space like a plastic or metal container, the beads will remove water from the air, creating and maintaining a very low humidity environment. Seeds (or other materials such as fruits or herbs) placed into a container with the beads will lose water due to the low air humidity, and will continue to do so until they come to equilibrium. Hence, desiccant-based drying simply transfers the water in the seed to the drying beads through the air without the need for heating. The drying beads can subsequently be removed and regenerated separately by heating at >200°C for 3-4 hours to release the absorbed water.

Advantages of Drying beads

A major advantage of bead drying is that it is not dependent upon the sun or direct sources of energy and it is independent of the ambient humidity. It does require the use of moisture-proof containers in which the beads and seeds can be enclosed.

The drying beads can subsequently be removed and regenerated separately by heating at >200°C for 3-4 hours to release the absorbed water.

Once both the beads and seeds are in the closed container, the transfer of water from the seeds to the beads will occur automatically. In addition, by enclosing the seeds in a container, they are protected from rodents, birds, insects, mould and rainfall. The time needed to spread and collect the seeds daily and protect them from birds and rainfall during open drying will be saved. Or the hours of expensive heated air drying in humid conditions. Once the seeds have reached the desired moisture content, the beads can be removed and the seeds will stay at that moisture content as long as they remain within the moisture-proof container. Seeds dried to these to low moisture levels can be stored for several years even at warm temperatures. it is more convenient to use this method with vegetable and other high value, low volume seeds than with the large quantities of seeds utilized in agronomic crops such as cereals or legumes. Nonetheless, there are ways to utilize drying beads on larger industrial scales and store the seeds in hermetic packaging.

Enclosing seeds inside of sealed containers goes against most traditional knowledge about seed storage. Enclosing moist seeds in such containers will result in damage due to mould and insects. Whilst traditional knowledge is correct in humid regions where it is not possible to dry the seeds to the low levels required for safe storage in sealed containers, in the case of Vanquish Beads however, the addition of drying beads to the seeds in the sealed containers, by lowering the seed moisture content, changes everything and results in the multiple advantages of greater seed longevity as well as protection from losses due to predation, insects and mould.

Why not just use silica gel or other desiccants?

Seed drying with desiccants is not a novel technology, and specific drying equipment based upon silica gel is available. Even other seeds, such as rice grains, when heated to dry them to very low levels, will absorb moisture from other seeds and act as a desiccant. However, silica gel has less affinity for water than Moisture Vanquish drying beads at the low humidity needed to dry seeds to optimal storage moisture contents. The beads are non-toxic and pesticide-free.

The drying beads are very hygroscopic than other existing water absorbents like silica gel, Charcoal, Baked Rice.

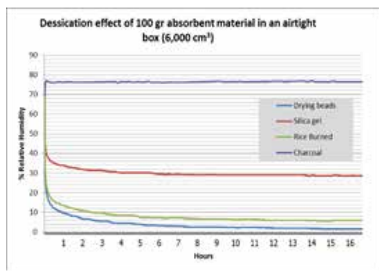
However, silica gel has less affinity for water than Moisture Vanquish drying beads at the low humidity needed to dry seeds to optimal storage moisture contents.

The Repeated use:

Baked Rice: One time

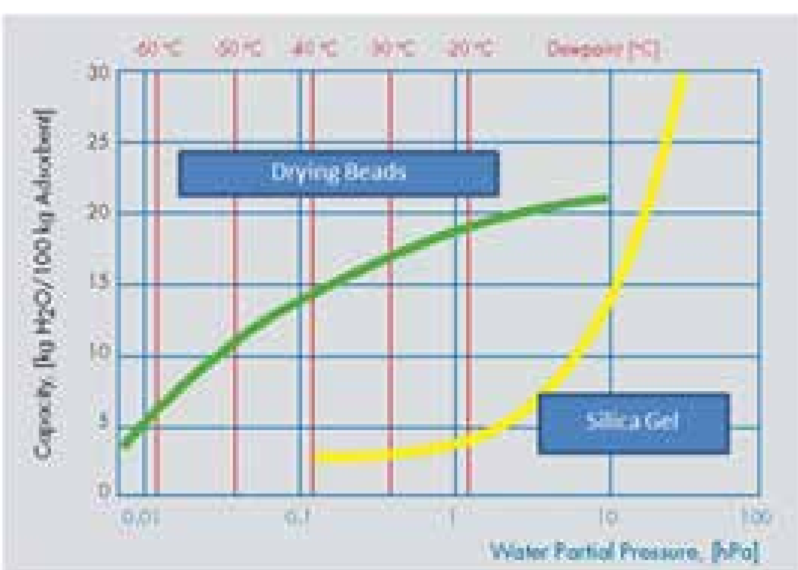
Silica Gel: Few times

Drying Beads: Life time

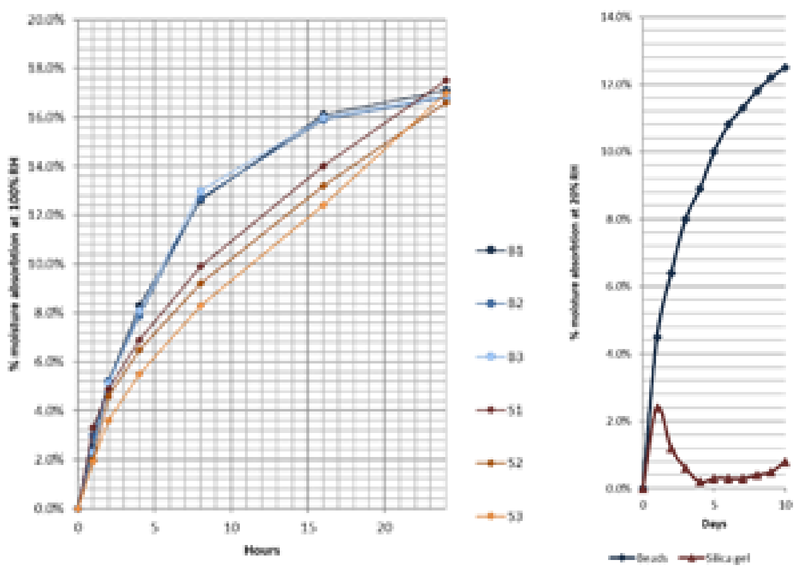


Advantages of Drying Beads over Silica Gel:

1. Absorption & Desorption: Beads absorption starts…till 1600C, desorption from 2000C, Ideal desorption starts from 250-3000C. Beads can regain fully absorption capacity after regeneration. But not the same with Silica Gel.
2. Easier in use than Silica Gel.
3. Higher performance than Silica Gel.
4. Longer lifetime than Silica Gel.



Differences in water absorption between the drying beads and silica gel:



Equipment requirements:

Any type of locally available airtight container (plastic, metal can, aluminium foil etc.) of any size can be used. A gasket inside the cap may be needed to ensure airtight conditions in plastic or metallic containers. A simple test can determine whether the container is airtight. Place a small quantity of fresh indicator silica gel inside the container for a few days. A colour change indicates that the container is not moisture proof. Beads can be mixed with the seeds for more rapid drying, and can be easily screened out from the seeds for reuse. Alternatively, the beads can be enclosed in a porous bag or container within the hermetic container for convenience. The only requirement is that beads and seed be in contact with the same atmosphere that is sealed from the external atmosphere. Wet seeds, such as fresh tomato or melon seeds, should be surface dried before mixing directly with seed drying beads. Note: adding liquid water directly to drying beads generates heat. Avoid bringing liquid water into direct contact with drying beads.

Can drying beads damage seeds?

If an excess of beads is stored with seeds, the seed moisture content will be reduced to very low levels. Most desiccation-tolerant ("orthodox") seeds are not damaged even when dried

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to 3-5% moisture. Some larger seeds, particularly cucumber, watermelon, bottle gourd and bean, can be damaged by rapid rehydration from very low moisture contents, called imbibitional damage. To be safe, it is a good practice to remove seeds from the sealed storage container and allow them to rehydrate in air under ambient conditions for a few days prior to planting or bringing into contact with liquid water. in most tropical regions, the ambient humidity will safely rehydrate the seed sufficiently to prevent imbibitional damage. Some seeds also become brittle when very dry and should be handled gently until they have had a chance to rehydrate from the humid air. This is particularly important for bigger seeds like beans. Some seeds (termed "recalcitrant") are damaged by drying and should not be dried using desiccant beads. Many tropical tree seeds like mango, durian, and palm or other seeds like citrus are recalcitrant and should not be dried using these beads.

Precautions

The beads release heat by an exothermic reaction when they absorb water. At the rate that water is absorbed from the air, this heat is readily dissipated and no discernible increase in temperature will be detected. However, if liquid water is added directly to drying beads, the rapid release of heat will raise the bead temperature to levels that can be injurious to the seeds and to workers. Thus, Do Not add beads directly to very wet seeds such as cucumber, melons or tomato seeds immediately after washing. Dry the seeds in air first to remove excess water before mixing directly with beads.

Other Uses

The drying beads can be used to dry herbs, fruits and vegetables, to purify essential oils, or other applications where the specific removal of water is desired.

What quantity of drying beads is needed to dry seeds?

The amount of drying beads required depends upon several factors:

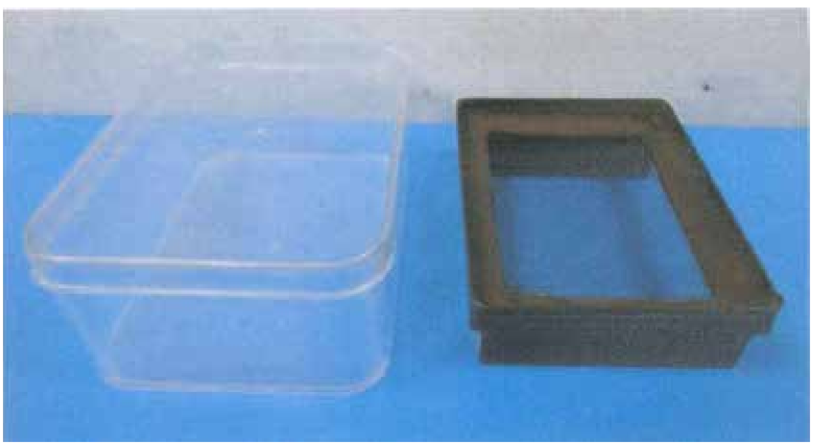
1) The water-holding capacity of the beads;
2) The quantity of seeds to be dried;
3) The initial seed moisture content; and
4) The final desired seed moisture content

Some seeds (termed "recalcitrant") are damaged by drying and should not be dried using desiccant beads. Many tropical tree seeds like mango, durian, and palm or other seeds like citrus are recalcitrant and should not be dried using these beads.

Therefore, the water-holding capacity of the drying beads can vary somewhat depending upon how they have been stored and handled prior to use.

Determination of Drying Beads capacity and equipment needed?

1. Plastic box or other kind of container and wire mesh, A water saturated environment (100%RH) or other water source



2. Beads should be weighed and then place inside container with water source

3. After leaving sealed for a day, the drying beads can be removed and weighed again

The final weight minus the initial weight is the weight of water absorbed, and dividing this value by the initial weight gives the water-holding capacity.

Drying beads water-holding capacity (%)

$$= \frac{\text{initial drying beads weight} - \text{final drying beads weight} \times 100}{\text{initial bead weight}}$$

- After heating for 3 to 4 hours, the beads should be cooled in a metal container with a lid (to reduce re-absorption of water) until they can be safely handled, then stored in a moisture-proof container at ambient room.

Vacuum sealing; incase of plastic bag we recommend to use less time than aluminum foil

DRYSTORE®

Storing Your Seeds in a Comfortable (Affordable) way for Short, Medium and Long Term, Even During Transport

DRYSTORE® is an airtight container with thermo-hygrometer and having a facility for uniform distribution of dry air throughout the container. It is used to dry the high moisture content seeds to desired moisture content using DRYING BEADS® and also to store the dried seeds properly by monitoring thermo-hygrometer (Temperature & RH) readings frequently.

Seed moisture content will come to equilibrium with relative humidity (RH) of their environment. This is the reason why when seeds are dried and stored out in the open, they will reabsorb the water until they reach their equilibrium. Unfortunately, this equilibrium moisture content (emc) in most environments is too high for proper seed storage.

Therefore we designed a system that not only keep your seeds in a sealed condition, but also will alert the seedsmen with a 'color/sign' warning when the environment inside the container is no longer sufficiently dry.

Drystore – 8.6 Ltr

Drystore – 100 Ltr

Monitoring moisture content and assessing shelf life fast and easy

Where & How to use Drystores:

Drying of small samples (upto 60 Kg batches is possible)

High quality storage of Seeds under ambient conditions

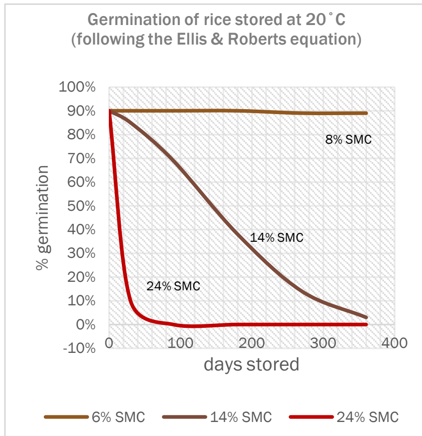
Storage of Breeder lines & foundation seeds…

Seed quality protection during transport

Seed moisture content will come to equilibrium with relative humidity (RH) of their environment. This is the reason why when seeds are dried and stored out in the open, they will reabsorb the water until they reach their equilibrium.

Soil-Test
Chilli – Germ 6 months storage

Normal Storage | Drying Beads Storage



Seed Drying prevents insects damage:

Dr. Keshavulu Kunusoth et al, experimented to study the effect of drying beads in controlling the storage pests in Mung bean.

Trial of Bruchids on mung bean

One big trial on Mung Bean (Vigna Radiata):

- Seeds were harvested and dried respectively in the sun (classical method) or with a calculated amount of drying beads (with the aim to bring it to a 4% SMC)
- 10 pairs of Bruchids were added by each sample (0.5 kg)
- Seeds were stored in open jute bags or in closed plastic containers

- Test was repeated with 4 reps and at 4 different time intervals (Feb 2012, Apr 2012, Jun 2012 and Aug 2012)
- Germination was obtained after 6 months of storage

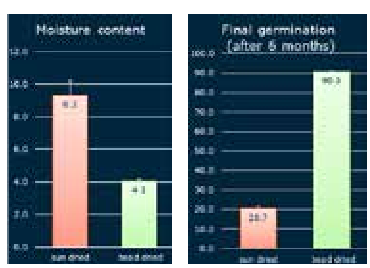
Types of storage:

Mung Beans In Cloth Bags, Inoculated With Bruchid Beetles.

Mung Beans With Drying Beads, Also Inoculated With Bruchid Beetles.

Seed Drying Prevents Insect Damage:

Bead-dried seeds were not consumed by bruchids.



The relationship between eRH and SMC

9.3% SMC equals to an eRH of 45% @ 30˚C

4.1% SMC equals to an eRH of 15% @ 30˚C

Through the Roberts & Ellis equation

9.3%SMC and 35˚C storage for 6 months – 95% reduces to 88%

4.1%SMC and 35˚C storage for 6 months – 95% reduces to 92%

Conclusion:

- The measured germination drop is mainly due to the insect damage
- The insect and disease pressure can be eliminated by reduction of the RH below certain thresholds.
- The reduction of the water content of the environment will reduce or even eliminate bacterial, fungal, insect and rodent damage of stored products.
- Reduction of fumigation needs which also damages the quality of seeds If fumigation is done repeatedly.

  - *Courtesy of Keshavulu Kunusoth, PJTSAU, Hyderabad, India*

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SEED CONDITIONING in Rice

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Introduction

Rice is a major staple crop consumed by roughly one-half of the world population, including virtually all of East and Southeast Asia. It is an edible starchy cereal grain and is eaten since ancient times. Many cultures have evidence of early rice cultivation, including China, India, and the civilizations of Southeast Asia. However, the earliest archaeological evidence comes from central and eastern China and dates back to 7000–5000 BCE.

With the exception of the type called upland rice, the plant is grown on submerged land in the coastal plains, tidal deltas, and river basins of tropical, semitropical, and temperate regions. The seeds are sown in prepared beds, and when the seedlings are 25 to 50 days old, they are transplanted to a field, or paddy, that has been enclosed by levees and submerged under 5 to 10 cm (2 to 4 inches) of water, remaining submerged during the growing season. The importance of this cereal to certain parts of the world may be seen in Sanskrit texts. In Hinduism, rice is revered as a potent symbol of auspiciousness, prosperity and fertility and therefore is used extensively in Hindu rites and rituals. Rice also plays an important part in Buddhist culture; it is considered sacred. Gautama Buddha's father's name was Shudhodana, which means Pure Rice.

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Cultivated rice crop, botanically known as Oryza sativa, genus Oryza is an annual grass of the Gramineae family. It grows to about 1.2 metres (4 feet) in height. The leaves are long and flattened, and its panicle, or inflorescence, is made up of spikelets bearing flowers that produce the fruit, or grain. In Asia the paddy is cultivated in three main types of soil, including clays with a firm bottom within a few inches of the surface; silts and soft clays with soft bottoms becoming hard on drying; and peats and "mucks" containing peat, provided the depth of the peat is not excessive. Fields must be drained and dried before harvesting. When combine harvesters or binder threshers are employed, the grain must be dried to about 14 percent moisture so that no deterioration takes place in storage. When reaper binders are used, the crop is "shocked" in certain ways so that the grain is protected from rain.

In the 1960s, the Green Revolution, produced improved dwarf high yielding strains of numerous food crops, including that known as miracle rice. The selected races were bred for disease resistance and increased productivity, the high potential disease resistant varieties were a widespread success. The rice is cooked by boiling, or soaking all night ang grinding into paste, steaming, frying etc. The rice is harvested when the crop turns golden yellow in the field. Harvesting is the process of collecting the mature rice crop from the field. Depending on the variety, a rice crop usually reaches maturity at around 105–150 days after crop establishment. Harvesting activities include cutting, stacking, handling, threshing, cleaning, and hauling. Good harvesting methods help maximize grain yield and minimize grain damage and deterioration. Seed priming stimulates the pre-germination metabolic processes and provides faster and synchronized germination. Seed priming could develop different defense mechanisms in seeds against biotic and abiotic stress.

The harvested rice kernel, known as paddy, or rough, rice, is enclosed by the hull, or husk. Milling usually removes both the hull and bran layers of the kernel, and a coating of glucose and talc is sometimes applied to give the kernel a glossy finish. Rice that is processed to remove only the husks, called brown rice, contains about 8 percent protein and small amounts of fats and is a source of thiamine, niacin, riboflavin, iron, and calcium. Rice that is milled to remove the bran as well is called white rice and is greatly diminished in nutrients. When white rice forms a major portion of the diet, there is a risk of beriberi, a disease resulting from a deficiency of thiamine and minerals. The weight of the husk is about 20 percent of the weight of the paddy, and there are losses of about 5 percent from dirt, dead grains, and other impurities. Approximately 74 percent of the paddy is available as rice and rice by-products.

Milling is a crucial step in post-production of rice. The basic objective of a rice milling system is to remove the husk and the bran layers, and produce an edible, white rice kernel that is sufficiently milled and free of impurities. The yield from milling and subsequent emery polishing includes about 50 percent whole rice, 17 percent broken rice, 10 percent bran, and 3 percent meal. Rice grains have a series of thin coats that can be removed or partially removed in the process of pearling and whitening. Parboiled white rice is processed before milling to retain most of the nutrients, and enriched rice has iron and B vitamins added to it. Bhattacharya Rice Intelligence System (BRIS) is a fully automatic and effective method to obtained the parboiled rice of the consumer preferences

Seed priming stimulates the pre-germination metabolic processes and provides faster and synchronized germination. Seed priming could develop different defense mechanisms in seeds against biotic and abiotic stress.

Rice Seed Conditioning

1. Harvesting

Harvesting is the process of collecting the mature rice crop from the field. The goal of good harvesting is to maximize grain yield, and to minimize grain losses and quality deterioration. Harvesting of paddy includes cutting, stacking, handling, threshing, cleaning and hauling of paddy. Harvesting can be done manually using sickles and knives, or mechanically with the use of threshers or combine harvesters. Harvesting systems vary from region to region and include different methods for harvesting, hauling, threshing and cleaning.

Correct timing of harvest is crucial in order to prevent crop loss. Grain losses may occur from rats, birds, crop lodging, insects, and shattering. Timely harvesting ensures good grain quality and high market value. Too early harvesting will result in a larger percentage of unfilled or immature grains, results in a lower yield and higher grain breakage during milling. Harvesting too late will lead to excessive losses and increased breakage in rice. Timing of harvesting also affects the germination potential of rice seed. Generally, the ideal harvest time lies between 130-136 days after sowing for late, 113-125 for medium, and 110 days for early. maturing varieties.

2. Threshing

2.1 Manual Threshing

The common method for threshing by hand is separating the grain from the panicle by impact. This can be done by hand beating, treading, or by holding the crop against a rotating drum with spikes or rasp bars. Hand beating methods are normally used for threshing rice that easily shatters.

2.2 Machine Threshing

Due the high labor requirements of manual threshing, in many countries threshing of paddy is now done by use of small stationary machine threshers. Depending on farm type, crops, resources available, post-harvest practices, threshers come in different sizes and range from small portable units without cleaner to large, truck mounted units. Threshing is either done in the field, near the field or at the nearest road.

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Combine Harvesting

As the name suggests, combine harvesters "combine" several operations into one: cutting, feeding into threshing mechanism, threshing, cleaning, and discharge of grain into a bulk wagon or directly into bags. Straw is usually discharged behind the combine in a windrow. In developing countries such as India, China and Thailand the use of combine harvesters for paddy rice is increasing rapidly.

3. Cleaning

Grain cleaning after harvest is an important step as it removes unwanted materials from the grain. Clean grain has a higher value than grain that is contaminated with straws, chaff, weed seeds, soil, rubbish, and other non-grain materials. Grain cleaning improves the storability of grain, reduce dockage at time of milling, and improve milling output and quality. Seed cleaning also reduces damage by disease, and improve yields. The steps of cleaning process are Winnowing followed by Sifting, Visual Inspection, and Grading. The goal is to maintain the seed purity.

4. Treating & Bagging

Prior to the sowing into the ground, the seeds must be protected against infestation by fungi and animal pests. In order to obtain an efficient protection, a uniform coating of the surface of each individual seed grain must be ensured.

4.1 Seed Priming

Seed priming refers to the process in which the seeds are hydrated to the extent that allows metabolic events of germination to take place without radicle emergence/ sprouting. Seed priming lead to the further improvement in germination performance and field uniformity. Higher yields from primed crop seeds are associated with reduction in damage from pests and diseases (Rashid et al., 2004). Seed priming is a practical and facile technique to enhance rapid and uniform emergence, high seedling vigor and yield in many vegetable, flowering plants (Di Girolamo and Barbanti 2012), and in some field crops (Hussain et al., 2016), particularly under unfavorable environmental conditions. Several seed priming approaches including hydropriming, nutrient priming, hormonal priming, chemical priming, osmopriming, and redox priming can be effectively used under different environmental conditions. Seed priming is effective in alleviating the adverse effects of submergence, and germination of the rice was increased by 44 and 46% (Hussain et al., 2016).

4.2 Nano Priming

Nanotechnology has the potential to revolutionize the agriculture and play an important role in food and crop production1, 2. During the past decade, a number of patents and products

Seed cleaning also reduces damage by disease, and improve yields. The steps of cleaning process are Winnowing followed by Sifting, Visual Inspection, and Grading. The goal is to maintain the seed purity.

incorporating engineered nanoparticles (NPs) into agricultural practices, e.g. nanopesticides, nanofertilizers, and nanosensors, have been developed with the collective goal to promote the efficiency and sustainability of agricultural practices requiring less input and generating less waste than conventional products and approaches. In recent years, several metal-based NPs (e.g., AgNPs16, AuNPs5, CuNPs17,18, FeNPs17, FeS2NPs19, TiO2NPs20, ZnNPs17,18, ZnONPs21) and carbon-based NPs (e.g., fullerene22 and carbon nanotubes23) have been applied as seed pre-treatment agents for promoting seed germination, seedling growth, and stress tolerance in some crop plants. In order to promote sustainable nano-agriculture, biocompatible silver nanoparticles (AgNPs) have been most commonly used as nanopriming agent for enhancing seed germination of rice aged seeds. Mahakham et al., 2017 demonstrated that AgNPs can be applied as nanopriming agent for enhancing seed germination and starch metabolism of rice aged seeds.

4.3 Seed Coating

Seed coating is another way of seed treatment that differently to priming seeds are not soaked in a nutrient solution but just sprayed to form a continuous layer on the seed (Rehman et al., 2018). Ros et al., 2000 reported that coating rice seeds with rock phosphate (RP) may be more promising for stimulating early rice growth on low P soils. The coating of rice seeds with zinc, the dosage of 0,77 g kg-1 seed, increases the number of grains per panicle and weight of grains per plant (Funguetto et al., 2010).

4.4 Seed Pelleting

Seed pelleting can be described as a process of adding inert materials to seeds with the help of binding agents. This process allows seeds to be uniformly increased in size and weight, making them more homogeneous and easier to mix and sow. Studies suggests that the rice plants emerging from the pellet have substantially high number of shoots (tillers) when compared to the normal direct sowing or transplantation methods and thereby has the potential for more grain from the shoots.

The treated seeds are then bagged for storage.

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5. Drying

Drying is the process that reduces grain moisture content to a safe level for storage. It is the most critical operation after harvesting a rice crop. Delays in drying, incomplete drying, or ineffective drying will reduce grain quality and results in losses.

6. Storage

The purpose of any grain storage facility is to provide safe storage conditions for the grain in order to prevent grain loss caused by adverse weather, moisture, rodents, birds, insects and micro-organisms like fungi. It is recommended that rice be stored in paddy form rather than milled rice as the husk provides some protection against insects and helps prevent quality deterioration. Further, when rice can be stored as brown rice, 20% less storage capacity will be needed.

Storage systems can be through bag, bulk, or hermetic or airtight containers.

1. Bag storage- grain is stored in 40–80 kg bags made from either jute or woven plastic
2. Bulk storage - grain is stored in bulk at the farm or at commercial collection houses
3. Hermetic storage - grain is stored in an airtight container so that that moisture content of the stored grain will remain the same as when it was sealed.

Rice grain is hygroscopic and in open storage systems the grain moisture content will eventually equilibrate with the surrounding air near the Equilibrium Moisture Content (EMC) [Rice Knowledge Bank, IRRI]. High relative humidity and high temperatures typical for the humid tropical climate lead to grains absorbing water in storage and to a high final moisture content.

Conclusion

With the ever-increasing population, the global demand for high yield and quality of rice is rising, we have a strong desire to understand better the importance of the different traits that make up the quality of the rice and obtain a full picture of rice quality demographics. The seed conditioning in rice, which has an important role to play in quality and yield has often been

Rice grain is hygroscopic and in open storage systems the grain moisture content will eventually equilibrate with the surrounding air near the Equilibrium Moisture Content (EMC) [Rice Knowledge Bank, IRRI].

neglected by the researchers and industrialists. The rice with better conditioning, is pure genetically as well as physically, is crucial to obtain better yield in the next generation. A pure seed also has higher demand and gets higher price and compared to ill-processed seeds. Only with additional tools and research will we be able to define directed strategies for paddy conditioning for improved yields and quality for larger gains to the farmers.

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