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Seed quality enhancement techniques

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Abstract
Seed is the basic input for agriculture. Seed is treated to enhance seed longevity, establish optimum and uniform plant population of healthy plants with reduced seed rate. Seed enhancement technologies are gaining increasing attention for their potential to confer greater disease resistance in seeds, improve seed vigor and modify seed emergence capabilities. For any crop, the time from sowing to seedling establishment is crucial, in which the seeds are exposed to wide range of environmental stresses. Seed quality is vital to sustainable crop production and food security. Seed enhancements include physical, physiological and biological treatments to overcome germination constraints by uniform stands, earlier crop development and better yields. Improved germination rates and seedling vigour are due to reduced emergence time by earlier start of metabolic activities of hydrolytic enzymes and resource mobilization. Nutrient management, ion uptake, hormonal regulation, activation of antioxidant defence system, reduced lipid peroxidation and accumulation of compatible solutes are some mechanisms conferring biotic and abiotic stress tolerance in plants. In this scenario, there is need to minimize the factors associated with reduced vigour during seed production, improve seed storage and handling, develop hightech seeds by seed industry at appropriate rates and integrate agronomic, physiological and molecular seed research for the effective regulation of high quality seed delivery over next generations.

Keywords: Seed, Seed priming, Seed coating, Seed pelleting, Seed colouring, Seed hardening, Seed fortification

Introduction

Seed is the main source of future plants or foods, seed is the first link in the food chain, and is the ultimate symbol of food security. Seeds are basic in crop production. No agricultural practice can improve a crop beyond the limits set by the seed.

Quality seed production is the main goal for successful agriculture, which demands each and every seed should be readily germinable and produce a vigorous seedling ensuring high yield. “Care with the seed and joy with the harvest” and “Good seed doesn’t cost it always pays” are the popular adage which enlightens the importance of the quality seed. The farmers always very much interested in the best seed management practices which are safe, environmentally sound and scientifically proven technologies. Understandably, in view of the importance of quality seeds in Agriculture, both as a product and as a means of establishing a crop, most attention at all levels of investigation has been directed to crop seeds.

Seed enhancements is defined as post-harvest treatments that improve germination or seedling growth, or facilitate the delivery of seeds and other materials required at the time of sowing. Seed enhancement is a range of treatments of seeds that improves their performance after harvesting and conditioned, but before they are sown. Seed enhancement include priming, hardening, pregermination, pelleting, encrusting, film coating *etc*, but excludes treatments for control of seed born pathogens (Black *et al.* 2006).

Objectives of Seed quality enhancement

- Improve germination/seedling growth through manipulation of seed vigour or physiological status of the seed.
- Facilitate seed planting (Pelleting, Coating and Encrusting).
- Deliver the materials (other than pesticides) needed at sowing (e.g. nutrients, inoculants).
- Remove weak or dead seeds using nontraditional upgrading techniques (density, color, sorting).
- Tagging of seeds with visible pigments or other materials/markers for traceability and identity preservation.

Seed Priming: The theory of seed priming was first proposed by Heydecker (1973).

It is the process of controlled hydration of seeds to a level that permits pre germinative metabolic activity to proceed, but that prevents actual emergence of the radical. Seed priming is used to increase rate of germination and uniformity. Subsequently, the seeds are dried, distributed and planted in the usual way. Primed seed usually exhibit more rapid and uniform emergence of seedlings from the soil compared to non-primed seed of the same seed lot. These differences are greatest under adverse environmental conditions in the field, *ex.* cold or hot soils. Primed seed often has a shorter shelf life than non-primed seed, and should be stored under optimal conditions prior to planting.

Types of Seed Priming

i. **Osmo priming:** Soaking the seeds in osmotic solutions (mannitol or inorganic salts, or polyethylene glycol).
ii. **Halo priming:** soaking the seeds in salt solutions
iii. **Bio priming:** soaking the seeds with biological agent's solution like Bacteria, Rhizobium *etc.*
iv. **Solid priming:** This consists of mixing seeds in an organic or inorganic carriers and water for a particular period of time. The moisture content of the matric brought to a level just below what is required for radicle protrusion. Seed water potential is regulated by the matric potential of the seed and during priming water is held by carrier of seeds can imbibe water form carrier till the equilibrium is reached.
v. **Matrix priming:** mixing with moist solid particulate materials, such as exfoliated vermiculite, diatomaceous earth or lignaceous shale (Taylor *et al.* 1988).
vi. **Hydropriming:** controlled imbibition, i.e. the continuous or staged addition of a limited amount of water, such as in 'drum priming' (Rowse, 1996), though hydropriming is also used to mean imbibition in effectively unlimited water for a short period of time.

Priming Agents

1. Water
2. Salts, NaCl, Na_2SO_4, KNO_3, $CaCl_2(NH_4)SO_4$, KCl etc
3. GRs: GA_3, CCC, Kinetin
4. Vitamins: Vitamin K_3, Nicotinic acid, Panthonic acid
5. Plant products: Garlic extract, Coconut water, Leaf extract of *Pongamia pinnata, Abizzia amaza, Prosopis juliflora.*

Significant improvement in field emergency, seedling character also high synchronization of silking and anthesis for maize genotype was achieved through the hydropriming for 24 hr (Nagar *et al.* 1998). Lee *et al.* (1998) conducted an experiment to find out the optimum water potential, temperature and duration for rice seed priming. Maize seed soaked by 2.5% KCl for 16hr reduced coleoptile and radicle length, while seed soaked in 20 ppm GA_3 for 30 min improved some germination traits, but could not affect grain yield (Subedi and Ma, 2005). Harris *et al.* (2007) reported that seed priming led to better establishment and growth, earlier flowering, increase seed tolerance to adverse environment and greater yield in maize. Rehman *et al*. (2011) reported that seed priming is a cost effective technology that can enhance early crop growth leading to earlier and more uniform stand with yield associated benefits in many field crops including oilseeds. Primed seeds actually exhibit increased germination rate, enhanced germination uniformity and enhanced speed of emergence and at times, greater total germination percentage (Basra *et al*. 2005; Shehzad *et al*. 2012). Dastanpoor *et al* (2013) studied that the seeds of sage were treated by hydropriming at three temperatures 10, 20 and 30 °C for 0, 12, 24 and 48 hours, among them hydropriming of 12 hours at 30 °C was found to be most effective in improving seed germination by 25.5 per cent as compared to that of non-primed seeds. Ghassemi-Golezani *et al*. (2013) observed that hydropriming treatments to lentil seeds increased the plant height, number of pods and number of seeds per plant, the 1,000 grain weight, the bilogical yield, the grain yield and the harvest index when compared to the control.

Seed Coating: Seed coating is defined as the substance applied to seed that does not obscure its shape. Seed coating examples are fungicides, microbiological treatments and micronutrients. The major benefit of a seed coating is that the seed enhancement material placed on to the seed. Small amount of seed is needed as compared to broadcasting is one of the most economical approaches for improving seed performance.

Methodology: The seeds are usually coated by the following methods.

a) **Dry seed dressing:** Seeds are treated with active ingredient or coating materials along with adhesives (liquid form). The seeds are stirred well or rotated in a drum for uniform coating. The coated seeds are shade dried and used for sowing.
b) **Slurry seed dressing:** Solvents or diluents such as water (@ 5 to 20 ml/ kg of seed) or fevicol (@ 10 to 20% or 30ml/ kg of seed) is used. The concentration of the diluents varies greatly with the seeds. The seeds are coated with the active ingredients, simultaneously with the adhesives or polymers diluted in the above diluents or solvents. Then the seeds stirred uniformly and coated seeds are allowed to shade dry and used for sowing. Care should be taken for the use of optimum concentration of adhesives and diluents for obtaining effective coating.

John (2003) reported that maize seeds coated with 3 g polykote, 2 g carbendazim, 1 mL imidachloprid, 30 g DAP and 19.7 g micronutrient mixture per kg of seed recorded higher germination and seed yield over control. Seed coating with commercial polymers diluted with nutrient instead of water may sow increased seed germination (Farooq *et al.* 2012).

Recent period, film coating, in which the active ingredient is applied in a quick drying polymer film around the seed, has gained popularity. A major advantage of film coating is reduced loss of active material from the seed during seed transport and handling

Types of film coating: Hydrophilic coating-coating with a hydrophilic polymer can reduce rate of water up take, lower solute leakage and improve emergence of seed. It is suitable for sowing in wet soils and hydrophobic coating-it increases in germination is due to fact that the fine particle in the coating act as wick or moisture attracting material or perhaps to improved seed soil contact. It is suitable for sowing in dry soils

Application of the film forming mixture results in uniform deposition of materials on each seed with little variation among seeds (Halmer, 1988). Qiu *et al.* (2005) conducted an experiment to know the effects of seed film coating with 0.0075% uniconazole on the growth and physiology from three varieties of rape (*Brassica napus* L.) subjected to waterlogging. Seed coating with uniconazole enhanced root vigour, increased root length, root volume and root dry weight. It also significantly enhanced leaf dry weight and ratio of root to shoot. Seed film coating with uniconazole also significantly increased the activities of the antioxidant enzymes, POD, CAT and SOD, and soluble sugar concentration during waterlogging.

Seed Pelleting: Seed pelleting technologies is used to alter seed shape, surface properties, density and size to enable more precise seed singulation and placement in the planting tray or soil. Singulation eliminates clustering of seed that leaves too much or too little space between plants within a row. Seed pelleting technology is also used to deliver a range of beneficial additives, including micronutrients and plant protection agents. To provide an opportunity to package effective quantities of materials such that they can influence the micro environment of each seed.

Procedure

This involves mainly 3 stages.

1. Stamping
2. Coating
3. Rolling

Initially the seeds are uniformly coated with adhesive materials (gum Arabica, gelatin, methylcellouse, polyvinyl alcohol, poly xyethylene glycol based waxes) in correct quantity and concentration. Then the filler materials (lime, gypsum, dolomite, rock phosphate, vermiculate, montmorillonite *etc.,*) are sprinkled on the coated seeds and are rolled on the filler material for effective and uniform coating.

-Filler materials are sprinkled on the coated seeds.

-Rolled on the filler materials for effective and uniform coating,

-Shade dries the pelleted seeds

-Sowing of pelleted seeds in required field.

Rice seed pelleted with calcium peroxide to increase oxygen availability in submerged paddy conditions can be obtained in Jan (Halmer, 1988). Narasimha Prasad (1994) noted increased seed yield and quality of the resulting seed of soybean crop raised with seeds pelleted with biogas slurry at 500 g kg^{-1}. In sunflower, seed pelleting with moringa leaf powder (250g) with DAP (100g), Azospirillum (25g) and and Trichoderma (4g) for one kg of seed, maximum plant stand and yield were reported. An increased in yield of 15 per cent was noticed both under irrigated and rainfed conditions (Anon, 2001). Ashraf *et al.* 2011 studied the influence of seed pelleting with micronutrients and leaf powder on quality of *Linum album* (flax) seeds. It was found that the Borax (100 mg/kg) gave a highest germination of 98.57 per cent with maximum seedling vigour index of 4269 compare to other treatments. Geetha and Bhaskaran (2013) reported that irrespective of ragi varieties, the seed hardening and pelleting treatments performed better. The seed hardening with 0.1 ppm brassinolide and pelleting with DAP at 30 g kg^{-1} + micro nutrient at 20 g kg^{-1} + arrapu leaf powder at 300 g kg^{-1} had positive influence on drought resistance which was evident from its increased physiological and biochemical aspects of seed both under laboratory and field conditions recording maximum field emergence, productive tiller, fingers/ear head, and higher seed yield.

Seed Colouring: Seed coloring is coloring of seeds with different naturally colouring dyes and artificial chemical dyes in order to enable brand identification and to give the seed a distinct and attractive look.

Methodology: For natural dyes, root, leaves, seeds, flowers can be used. For examples *Jamun, Basella, Opuntia*. The fruits when fully ripened were fed into the pulper and the dye is extracted. In case of *Henna*, the leaf powder is mixed with water and used. In case of *Beetroot*, the root portion is cut into pieces and fed into the pulper and the dye is extracted. For *Turmeric*, the rhizome powder is mixed with water and used. In case of *Anatto*, the seeds are soaked in water @ 1:1 ratio. The dye is extracted and used. In case of *Hibiscus* and *Marigold*, the flowers are crushed and the dye is extracted. For chemical dyes, the powder is mixed with water and then they are treated with seed, the different concentrations used

The different concentrations used are

1. Congo red-0.25, 0.5, 0.75, and 1.0%
2. Bromocresol green-0.25, 0.5, 0.75, and 1.0%
3. Jade green-0.25, 0.5, 0.75, and 1.0%
4. Sky blue-0.25, 0.5, 0.75, and 1.0%
5. Turquoise blue-0.25, 0.5, 0.75, and 1.0%
6. Pink CM-0.25, 0.5, 0.75, and 1.0%
7. Direct chambagu-0.25, 0.5, 0.75, and 1.0%

Tonapi *et al.* (2006) investigated to know the effect of seed colouring on paddy and maize seeds encompassing 25 dyes to identify non-deleterious and deleterious dyes based on their effect on seed quality. The dyes especially Rhodamine-B, Fast green and Fuchsine in order of preference both for paddy and maize are the best dyes for seed colouring at 0.75% concentration. Babu *et al.* (2007) conducted a study to know the effect of seed colouring of redgram, blackgram and bengalgram seeds encompassing 25 dyes. The dyes especially Rhodamine-B, Fuchsine and Titan yellow for redgram, Rhodamine-B, Fuchsine and Phenol red and Rhodamine-B, Crystal violet, Titan yellow for bengalgram were found to be the best dyes for seed colouring at 0.75% concentration.

Seed Hardening: It is the process of hydrating the seed to initiate the pregerminative metabolism followed by dehydration which fixes the biochemical events.

Why it is done

- To impart resistance against the stress conditions like drought and cold, to the emerging seedlings.
- To accelerate the rapid germination and growth rate of seedling.
- To enhance the thermo tolerance of the seed without loss of viability.

Vigneshwari (2002) reported that seeds hardened with brassinolide 0.1 ppm had positive effect on drought resistance which was evident from its increased physiological and biochemical aspects of finger millet seeds that resulted in increased yield of seed. Many studies on the improvement of growth and yield due to pre sowing seed hardening are documented (Solaimalai and Subbarmanu, 2004; Meek and Oosterhugs, 2005). Kavitha *et al.* (2013) conducted an experiment to know the effect of seed hardening and film coating on crop growth and yield of sorghum cv. CO (S) 28 under Neyveli Lignite mine spoil condition. The results indicated that seeds hardened with 2% KH_2PO_4 and film coated with carbendazim @ 2 g kg^{-1} + imidachloprid @ 1 mL in 5 mL of water + 30 g DAP + 20 g micronutrient mixture +

pink polykote @ 3 g kg^{-1} + *Azospirillum* @ 40 g kg^{-1} of seed recorded higher germination (98%), vigour index (3695), dehydrogenase activity (0.50 OD value), α-amylase activity (6.2 mm) and total seedling chlorophyll content (1.71 mg g^{-1}) under laboratory evaluation and the same treated seeds sown in enriched mine spoil recorded higher emergence (96%), root length (23.1 cm) and root volume (3.8 cm3) at vegetative stage, plant growth parameters, earhead length (26.5 cm), earhead weight (46.91 g $plant^{-1}$) and grain yield (12.98 g $plant^{-1}$) under pot culture evaluation. Patil *et al.* (2014) conducted an experiment to study the effect of seed hardening with different chemicals *viz*. CCC, $CaCl_2$, $ZnSO_4$, KNO_3, water soaking and untreated (unsoaked) control on drought tolerance in *bt* cotton hybrid. The results reveal that, hardening of cotton seeds with $CaCl_2$ (2%) or CCC 100 ppm or CCC 150 ppm recorded significantly more yield. Germination percentage, total dry matter (TDM), relative water content (RWC), leaf chlorophyll content and gas exchange parameters, number of bolls and boll weight were significantly high.

Seed Fortification: It is the impregnation of the needy substance into the seed through the imbibition phase and enriches the endogenous level of the needy bioactive substances. The main objective of the seed fortification is to invigorate the seed for better establishment and improved productivity. It is done to improve the germination and seed vigour by infusion of bioactive chemicals into the seed.

Methodology

In seed fortification, seeds are soaked in solutions of equal volume/in different seed to solution ratio for duration of 6-12hr depending upon the crop to raise the moisture content of the seed to 20-25 per cent just enough for endogenous impregnation of chemicals through exogenous application. Then the seeds are sown after surface drying for easy handling or as such (not specified for drying back to original moisture content).

Factors influencing Seed fortification:

a) Choice of Bioactive substances (growth regulators, organic acids nutrients and seed protectents *etc.*)
b) Duration of soaking (2-24hr)
c) Concentration of chemicals.

Seed fortification with $MnSO_4$ at 0.5 to 1 percent will improve oxidative-reduction potential of seed, which ultimately leads to higher germination. To improve the iron content of rice, Goto *et al.* (1999) transferred the entire coding sequence of the soybean ferritin gene into *Oryza sativa* (L. cv. Kita-ake) by *Agrobacterium* mediated transformation. The rice seed storage protein glutelin promoter, *GluB-1*, was used to drive expression of the soybean gene specifically in developing, self-pollinated seeds (T1 seeds) of transgenic plants. Stable accumulation of the ferritin subunit in the rice seed was demonstrated by western blot analysis and its specific accumulation in the endosperm by immunologic tissue printing. The iron content of T1 seeds was as much as threefold greater than that of their untransformed counterparts. Vishwanath *et al.* (2015) conducted an experiment to study the effect of spent wash and cow urine on the germination and vigour of maize, paddy and ragi. The spent wash and cow urine increased the seed quality parameters in terms of seed germination, seedling vigour and field emergence. Concluded as spent wash and cow urine can be used as a seed fortification treatment to get better seed quality. Umesha and Channakeshava (2015) revealed that seeds fortified with 1% $MgSO_4$ as a pre sowing seed invigourative treatment improved the plant growth, seed yield and quality of cluster bean (*Cymopsis tetragonoloba* (L.) Taub.). The percent improvement in seed yield due to $MgSO_4$ fortification was 21.66 than unfortified seeds. Hence, seed fortification with 1% $MgSO_4$ could be recommended for cluster bean as a pre-sowing seed invigourative treatment.

Advantages of Seed Quality Enhancement Technology

- Reduced seed rate
- Early emergence and reduced time of emergence under stress conditions
- Supply of growth regulators/nutrients/beneficial microbes
- Better nursery management
- Helps seedling to dominate weeds in competition for nutrition
- Field stand and uniformity
- Minimum exposure to toxicant
- Direct seeding of conventionally transplanted vegetable seeds.
- High turnover

Conclusion

Seed quality enhancement approaches has been used to improve germination, reduce seedling emergence time, improve stand establishment and yield. The beneficial effects of quality enhancement techniques have been demonstrated for many field crops. It is the best solution of germination related problems especially when crops are grown under unfavorable conditions and prompts market value of seeds. Many Seed quality enhancement techniques have been evolved which are being utilized in many crops now days. It can enhance rates and percentage of germination and seedling emergence which ensure proper stand establishment under a wide range of environmental conditions.

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