A REVIEW ON SEED ENHANCEMENT IN AGRICULTURE CROPS

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ABSTRACT

Quality seeds along with other improved package of practices play a vital role in improving productivity of crops under drought condition, seed enhancement is a practice adopted to make crop plants resistant to soil moisture stress, Nacl, Na_2SO_4, KCl, $MgSO_4$, KH_2PO_4, K_2SO_4, $CaCl_2$, Na_2HPO_4, Nitric acid, cow urine, cow dung, Panchagavya, Vermicompost, Prosposis and Pungam, Neem botanical leave extraction are used as seed enhancement with both chemicals and organic. Seed enhance process, a number of photochemical changes occurs modifying the protoplasmic characters and increasing physiology activity of the embryo and associated structure. In this technique, pre-sowing seed enhancement with different chemicals and organic (botanical leaves extraction) improve seed viability and vigour as well as germination percentage, shoot length, root length and yield attributing characters in drought crops. Research carried out on seed enhancement in this review paper.

Keywords: *Botanical leaves extraction, chemicals treatment, seed vigour and viability, seed quality parameters.*

Genesis of the concept of seed hardening:

Research on methods to tackle drought started as early as 1883 when Will, H. made the first report that repeated soaking and drying of the seeds result in increased drought and frost resistance by the vegetative plant. This age-old technology of seed hardening can thus be defined as "training the seeds under lab conditions to withstand and continue productive plant growth even under adverse field condition of drought, heat and salt".

During hardening process, a number of photochemical changes occur modifying the protoplasmic characters and increasing physiology activity of the embryo and associated structure. This results in the absorption of more water due to increase in the elasticity of cell wall and development of stronger and efficient root system.

Physiological basis:

- Greater hydration of colloids
- Higher viscosity and elasticity of protoplasm
- Increase in the physiological activity of the embryo and associated structure
- Increase in bound water content
- Increase in photosynthetic activity
- Increase in hydrophobic colloids and decrease in hydrophilic colloids
- Increase in temperature requirement for protein coagulation
- More intensive respiration
- Lower water deficits
- Increase in water balance of plants
- More efficient root system

Principle involved:

Dry seed

⇩

Imbibitions

⇩

Permits initials process of germination

⇩

Dehydration

⇩

Prevents radical emergence

⇩

Shade and sun drying (drying back to original water content)

⇩

Hardened seed

⇩

Sowing

⇩

Remember the germination process where it had stopped

⇩

Rapid germination and establishes its seedling quickly

⇩

Increased seed yield and production of good quality seed

Chemical hardening:

Apart from mere water soaking as a method to harden seeds, chemical solutions have also long been considered for increasing crop production under rainfed condition. Perusal of literature reval that first report on chemical hardening of seeds was made by J.J. Chinoy, way back in 1947.

There have more beneficial effect were attributed to the nutritional aspect. Sashidar *et al*, (1977) reported calcium chloride hardened plants accumulated more proline under stress and ability of such plants to tolerate also seems to be better.

Organic seed treatment:

The indigenous and biodynamic preparation such as compost preparation can be used in organic nutrition management. Organic seed are treatment normally with material from organic sources used cow dung, panchagavya seed enhances.

As it is often not possible disease-free seed and as conventional affective seed treatment with synthetic compounds is not possible, a lot of work an alternative seed treatment has been done and is still going on (kalyani kumari *et al.*, 2013)

Organic agriculture is based on principles of self-sufficiency, biodiversity, crop rotation, recycling and independency of chemically based agricultural systems. Organic fields should be fertilized with manure from organic animals, organic animals should be fed with organically produced fodder and organic crops should be produced from organically produced seeds. Most conventional seeds are treated with fungicides, which is not an option in organic agriculture. To meet the requirements of the organic farmers and consumers, we have to scale up and further build up the expertise on organic seed production protocols and establish a good knowledge sharing mechanism. To make organic farming more acceptable and for adaption by large number of farmers, supply of good organic seed developed by organic breeding assumes greater importance in the coming years.

Panchagavya: It is a prepared by organic growers using the following ingredients and methodology:

Biogas slurry/cow dung 5 kg, cow urine 3 litres, cow milk 2 litres, curd 2 litres, clarified butter/ghee 1 litres, sugarcane juice 3 litres, palm sugar 1 kg, tender coconut water 3 litres, banana are the ingredients. The ingredients are mixed in a mud pot after stirring them well. Then, it is kept in a shady place for one week for fermentation. Then 3 litres of Panchagavya are diluted in 100 litres of water. This mixture is sufficient for spraying four acres. The diluted mixture has to be thoroughly stirred for 20 minutes before spraying. It can be stored for one month. It reduces vegetative growth and enhances quick flowering and also gives resistance against pests and diseases (kalyani kumari *et al*., 2013)

Biochemical properties of Panchakavya (Somasundaram 2003).

Contents	**Quantity**
Total N (ppm)	382
Total P (ppm)	238
Total K (ppm)	356
Total sugars (ppm)	205
Reducing sugars (ppm)	92
Glucose (mg/dl)	6.0
Total N (ppm)	92
Total organic carbon (%)	0.80
IAA (ppm)	9.15
GA (ppm)	4.0
Bacteria (CFU/ml)	24×10^6
Fungi (CFU/ml)	1×10^3
Actinomycetes (CFU/ml)	3×10^3
Pseudomonas (CFU/ml)	45×10^3
Yeast (CFU/ml)	35×10^4
Lactic acid bacteria (CFU/ml)	18×10^5
Methylotrophs (CFU/ml)	5×10^3
Azospirillum (CFU/ml)	2×10^2
Acetobacter (CFU/ml)	43×10^3
Ammonium oxidizes (CFU/ml)	24×10^5
Nitrite oxidizes (CFU/ml)	2×10^2
Ph	5.12
EC (dSm-1)	9.9
Zn (ppm)	0.26
Fe (ppm)	0.83
Mn (ppm)	0.23
Cu (ppm)	0.20

The literature on the effect of seed treating chemicals and organic on the rice are present in this chapter. Since limited literature are available in these aspects the review with other related crops are also included in this chapter.

Viswanath *et al.* (1972) studied the effect of seed hardening of ragi with calcium chloride, ascorbic acid and benzyl adenine. The authors recorded better germination capacity and more vigorous seedling growth in plants emerged from hardened seeds.

Shashidhar *et al*., (1977) reported calcium chloride hardened plants accumulated more proline under stress and ability of such plant to tolerate drought also seem to be better.

Hardening also improved the repair mechanism both structural and genetic. Improved membrane integrity in the treated seeds resulted in lower seed leachates (Rudrapal and Nakammra, 1988).

Karivaratharaju and Ramakrishnan (1985) reported that the hardened seeds of ragi with chemicals like adenine ascorbic acid, calcium chloride, KNO_3, $NaCl_2$, Succinic acid and zinc sulphate, recorded more tillering, increased dry matter production and significantly more yield.

Arjunan and Srinivasan (1989) stated that seed hardening of groundnut with 1 per cent calcium chloride had given significally increased pod yield, increased germination, higher dry mater accumulation and more number of mature pods per plant.

Seeds of three rice *Cv.* PTB 23, Mashuri and Aswarthy soaked in 10% cow dung extract for 12h registered more germination and root and shoot length compared with the untreated seeds (Joseph and Nair, 1989).

Kamalam and Nair (1989) revealed that hardening of rice seeds with 10 per cent cowdung extract registered its superiority in earliness, germination, root and shoot growth arid vigour index.

Lai and Luo (1989) suggested that dry seeds of 2 varieties, 2 hybrids and 1 male sterile line of *indica* rice treated for 3 days with 0.5% hydrogen peroxide solution before sowing recorded more germination and increased esterase isoenzyme bands compared to control.

Shanmugasundaram and Kannaiyan (1989**)** observed that when the *Pennisetum typhoides* seeds were soaked in l00ppm cycocel or 0.15% succinic acid or 1.0% sodium chloride, the highest percentage of germination was obtained.

Vanagamudi and kulandaivelu (1989**)** observed in pot trails that sorghum seeds soaked in water, 0.5 per cent potassium dihydrogen phosphate or 1 per cent sodium chloride exhibited accelerated emergence and increased root and shoot length.

Ascherman *et al* (1992) stated that anaerobic pre treatment of wheat seeds in deionized water twice their volume at 20°C under fluorescent light for 12h improved germination rate and root dry weight.

Bennet *et al.* (1992) reviewed on seed priming, presowing imbibition treatment, seed coating and biological seed treatments of protecting seeds against damping off or rooting.

Singh *et al*., (1992) found that castor seeds pretreated with KNO_3 @500ppm recorded the highest germination (54 per cent) and was followed by zinc sulphate at 100ppm (50 per cent) and H_2O (44 per cent)

Narayana swamy (1993) pre soaked groundnut seeds in 0.5% $CaCl_2$ for 6 hrs and shade dried. He observed increased germination (89%, control: 75%), field emergence (89%, control: 75%), plant height (55cm, control: 51.87 cm), number of graded capsule (26, control: 20), graded capsule yield per plant (17g, control:15g) and per hectare (1614 kg, control: 1260kg).

Paul et al. (1993) investigated the effect of presowing seed hardening with potassium salts on growth and yield of wheat under rainfed conditions and reported that performance of seed when hardened with 1% KCl and 1% KH_2PO_4 for 18 hrs was superior to dry seeds in respect of grain yield. These two treatments had better values for ear bearing tillers m^{-1}, number of grains ear and 1000 weight there by indicated that these treatments had induced drought tolerant capacity to the plants which could resist dry period and increased grain yield over non treated seeds.

Paul and Choudhury (1993) observed that wheat cv. Sonalika seeds in 0.5 or 1.0 or 2.0% concentration of potassium chloride *(*KCl) or potassium dihydrogan phosphate (KH_2PO_4) or potassium sulphate (K_2SO_4) for 18h registered more germination, shoot length, root length and seedling vigour.

Rangasamy *et al.* (1993) found that calcium chloride at 0.4% and cycocil (CCC) at 0.2% improved germination, vigour index and root shoot ratio in sorghum, pigeon pea, groundnut and cowpea.

Vasundhara (1993) found the soaked groundnut seeds in 1% KNO_3 and 1% $CaCl_2$ for 6hrs and shade dried. Reported improved seed germination to 59 and 43 per cent respectively compared to control (40%).

The beneficial effects of water soaking and chemical treatments in inducing growth and yield might be attributed to leaching out of toxic mebabolites form the seed, antifungal and anticatabolic effects of the treatment (Basu, 1994).

Bhaskaran (1995) obtained maximum augmentation of seed yield and quality attributes from rice, when the seeds were hardened with potassium dihydrogen phosphate (0.5%) and potassium chloride (1%) sorghum seeds hardened with potassium dihydrogen phosphate performed significantly better than control.

Sheela and Alexander (1995) gave pre sowing hardening treatment to rice seeds with water, Na_2 HPO_4 156ppm, Triazole 0.03g kg^{-1} seed, 2.5% KCl and 10% cow dung and observed that these treatments improved the physiological characters in the plants.

Jegathambal and Nagaraj (1996) stated that hardening with KCl and $CaCl_2$ @ 1 per cent concentration registered maximum germination and seedling vigour in rice Cv. Park and TMV 10.

Li Mei-ru *et al*., (1996) reported that the cold-hardened seedlings from seeds pretreated with $CaCl_2$ grew faster and better in the recovery period of chilling stress than those from seeds without $CaCl_2$ pretreatment. This promotive effect of $CaCl_2$ treatment on seeds prior to cold-hardening of seedling could be associated with an augmentation of membrane protectivity induced by the combined treatment.

Nagaraj (1996) opined that rice cv. PMK 2 when hardened with 1% KCl for 12hrs registered maximum germination and vigour.

Chandrasekhar *et al.* (1998) investigated the effect of seed hardening on either of seed hardening on the tolerance of wet seeded rice to herbicides (Anilotos, Butachlor, pretilachlor) and found that seed hardening with 1% $CaCl_2$ for 12 hrs resulted in lower pre-emergence herbicide toxicity with maximum grain yield of 5.85 and 5.92 tonnes ha^{-1}.

According to Palanisamy and Punitharathi (1998) the seeds of ragi hardened with chemical like KCl, $CaCl_2$ and aequeous leaf extracts like prosposis and pungam each at1%

concentration as well as their combinations for 24h recorded high germination and seedling vigour characters over control.

Seed soaking with overnight in tap water resultant in early emergence, deeper roots, early flowering and maturity and higher yield in upland rice (*Oryza sativa),* and (*Cicer arietinum* L.) and corn (Harris *et al.,* 1999).

Andon and kobata (2000) gave wetting and drying treatments to the seeds of eight rice cultivars before sowing at different soil water and reported that hardening treatment with shorter soaking during increased the speed of germination and coleoptile length and they also reported that soaking duration longer than 36h had harmful effects on the seeds.

Lee and Kim *et al*., (2000) reported that sugar content and the α- amylase of normal seeds were higher than of aged seeds.

Nam Taegsu and Woo (2000) reported that a rice seeds soaked in 50ppm gas promoted elongation of mesocotyl and stimulation by GA_3 was enhanced by the addition of $CaCl_2$ 2%.

Babu and Thirumurugan (2001) with sesamum cv. TMV 3 revealed that in salinity induced soils (using35, 70, 140mM NaCl) seeds primed with 1.0M NaCl increased the plant height, number of capscules and seed yield.

Harris et al. (2001) reported that rice sown after soaking in water for overnight and surface dried had showed faster emergence and more uniform stand. Hence there was less need to resow, the treatment also produced more vigorous plants with better drought tolerance, early flowering harvest and higher grain yield.

Kalairani *et al.* (2001) confirmed the beneficial effect of hardening /presowing treatment with 1%KCl and 1%$CaCl_2$ by increased leaf area index and chlorophyll satility index in ragi.

Biodigested slurry incorporation at 5 t ha^{-1} along with rhizobium inoculation recorded maximum plant height and grain yield in greengram (Nagarajan and Balachandar, 2001).

Sanchez *et al*., (2001) gave hydration dehydration treatments with water to tomato, cucumber and pepper seeds for 1h and 2h and recorded the increased germination percentage and thermo tolerance of seeds.

Osmohardening with KCl and $CaCl_2$ gave the most pronounced effect in enhancing emergence and yield. In addition to successful hydration during priming, these salts proved beneficial because of their role in enzyme activation, in particular, of hydrolases. This is plausible as a positive correlation exists between seed vigor and field performance of rice (Du and Tuong 2002).

Kurdali *et al*., (2002) explain that potassium alone as a means of alleviating salinity stress was found insufficient and appeared that the beneficial effect is due to stimulated growth rather than mitigating nitrogen deficiency in chick pea.

Ruan *et al.*,(2002) reported that rice seeds primed with $CaCl_2$+ NaCl showed higher germination time. It also improved seedling vigour index and stand establishment in flooded soil.

Improved kernel quality had been observed in direct seeded rice osmo hardened with KCl and $CaCl_2$ under flooded conditions (Zheng *et al*., 2002).

Giri and Schillinger (2003) compared the performance of wheat seeds variety Madsen when soaked with different chemicals (KCl 2% and 4%, PEG 10% and 20%, KH_2PO_4 0.5%

and 1%) and water at different durations and found the seeds soaked with water 12 hrs showed higher field emergence and grain yield.

Pawar *et* al., (2003) the present investigation revealed that seed hardening with $CaCl_2$ @ 2% followed by $ZnSO_4$ @ 0.1% for 6 hours found to be beneficial for increasing grain yield in sunflower under dry land situation.

Reddy *et al.,* (2003) Seed hardening with 1% $CaCl_2$ or 2% KH_2 PO_4 was most effective for groundnut.

Panchakavya and vermicompost combination had given the highest pod yield of French bean variety Ooty 2 which was 36% higher than the conventional method (Selvaraj, 2003).

Prakash and Kalaswamy (2004) reported that effect of seed hardening on yield and its components in KBSH 1 sunflower hybrid was significant $CaCl_2$ @ 2% concentration showed increased plant height (134 cm), head diameter (17.7 cm) and 100 seed weight (7.13 g) as compared to unsoaked and water soaked control.

Rhizomes applied in cowdung slurry induced better growth and vigour in the buds in ginger (Prakash et al., 2004) and in turmeric (Sundararaman, 2004).

Biogas slurry is the residual effluent after fermentation of organic waste and animal dung from the biogas plant (Thomas and Ramesh, 2004).

Solaimalai and Subburamu (2004) Pre-sowing seed hardening with different chemicals improve seed viability as well as vigour, root length, root shoot ratio and yield of rainfed crops. Research carried out on seed hardening is reviewed in this paper.

Basar *et al*., (2005) observed that wheat seeds of genotypes Augab 2000 responded to different pre sowing treatment and found that seed hardened with for 24hr showed maximum germination, field emergence and longer roots.

Mohanasarida and Jose Mathew (2005) hardened seed with nutrient solutions, plant protection chemicals, botanicals, organic manures and biofertilizers and reported that hardening the seeds with imidadotrid produced the highest yield of 5.3 t ha^{-1} and it recorded the yield increase of 2.1 t ha^{-1} over the untreated control.

Muhammad and Basra (2005) studied the effect of hardening in coarse and fine rice and observed the maximum vigour enhancement with higher germination and seedling vigour and low electrical conductivity of seed leachates in the seeds hardened with water for 24hrs (1cycle), and the effect was similar to that of seeds hardened for 12hr (2cycle).

The seed treatment and foliar application of panchakavya helps improving the plant growth and reducing the disease incidence of rice (Ramakrishna *et al.,* 2005).

Srimath *et al*., (2005) reported that among the various chemicals seed hardening with KCl 1% improved the seed germination (94%) and other quality parameters compared to control (82%) in Black gram.

From this experiment, reported there is a possibility of improving the seed quality through pre-soaking treatments with cheap, non-toxic and ecofriendly organic sources. These results have great practical significance, Since it indicates the possibility of upgrading the quality of seed with the help of simple seed treatment. Looking at the cost of organic substances, these organics are cheaper and easy to be practiced by everyone at rural area (Arjun Sharma e*t al.,* 2006).

Farooq *et al.* (2006) from the present study, it is concluded that osmopriming and hardening can successfully be integrated for vigor enhancement in coarse and fine rice. Osmohardening with $CaCl_2$ performed better than all other treatments including control in both coarse and fine rice.

Farooq *et al.,* (2006) observed that rice seeds osmohardening with calcium chloride ($CaCl_2$) produced the highest number of tillers per unit area and 1000 kernel weight.

Girase *et al.* (2007) reported that presowing seed treatment enhanced germination seedling establishment and yield in Sorghum genotype 2077 B.

Geetha *et* al., (2007) the present investigation explained that seeds hardened with 2% KH_2PO_4 for 16 hrs. Prior to sowing increased productivity in sorghum under rainfed cropping system.

Jegathambal and Shanmugam (2007) revealed that germination percentage and vigour index were maximum in seeds soaked with KNO_3 @1 per cent solution of 24h when compared to unsoaked seeds.

Muhammad Farooq *et al.* (2007) reported that osmohardening with $CaCl_2$ produced 3.75 t ha^1 (Control: 2.87 t ha^1) kernel yield, 11.40 t ha^1 (Control: 10.03 t ha^1) straw yield and recorded 24.57 % (Control: 22.27 %) harvest index in rice.

Paramasivam *et al*., (2007) stated that when $CaCl_2$ was combined with NaCl, $CaCl_2$ altered the overall plant metabolism to ameliorate deleterious effect of NaCl stress and increased the vegetative growth of plants.

The seed germination and seedling vigour of black gram cv. Vamban 3 could be improved by soaking by the seeds in 0.5 % KNO_3 for 4h duration (Surulitrajan 2007).

Jahangir *et al.* (2008) reported that in ground nut seeds soaked in 0.50% $CaCl_2$ solution for 32 hours significantly increased plant height (43.89 cm per plant) compared (41.50cm per plant). They also reported that 0.50% of $CaCl_2$ solution recorded higher pod yield per plant, and number of pod per plant (24.40 to 25.61).

Kathiravan *et al.* (2008) reported that seedling quality characters *viz.,* root length (2.9 cm), shoot length (34.5 cm), number of leaves (15.6) and stem girth (3.9cm) were highest with KCl @ 1% for 24h when compared to control in *Jatropha curcas Linn.*

The possible reason for higher growth characters and increased height might be due the growth enzymes present in panchagavya which favoured rapid cell division and multiplication (sanjutha, *et al*., 2008).

Yoganand (2008) reported that seed hardening with organics showed beneficial effect on various seed quality parameters. Significantly maximum germination was observed in seeds treated with vermiwash in chickpea.

Audi *et al*., (2009) reported the result also emphasized that pre-sowing hardening treatment of cowpea seeds in IAA and GA3 could significantly enhance their germination and seedling growth. This suggested that hormone treated cowpea seed have the potential of overcoming adverse effect of water stress in tropical Savannah.

Muhammad Farooq *et al.* (2009**)** reported that osmohardening with $CaCl_2$ was the most effective. Increasing rice production with judicious use of water is need of the day and aerobic rice cultivation is an attractive alternative for this purpose in rice.

Muhammad Farooq *et al.* (2009) reported that osmohardening (KCl) performed better than all other treatments, followed by osmohardening ($CaCl_2$) and ascorbate priming in rice.

Pre sowing hardening of crop seeds is prescribed to withstand adverse field conditions like water deficit, salinity and poor fertility under dry land conditions. Seed hardening accelerates rapid germination and growth rate of seedlings (Jerlin and sumathi, 2010). Hardening treatments with chemicals, nutrient solutions, growth regulators and botanicals have been developed as a potential agro-technique to induce drought tolerance without impairing the germination potential of seeds. Pre treatment of seeds with nutrient chemicals produces physiological effects on seed and increase the yield.

Papaya Saha *et al.*,(2010) stated mungbean plant can acclimate to lethal level of salinity pretreatment with level of NaCl.

Omidi (2010) reveals that seed hardening help to activate the performance of various stress regulating enzyme/ systems (Osmalites).

Hafeez Ur Rehman *et al.,* (2011) reported that osmohardening with $CaCl_2$ can therefore be employed for better crop stand, growth, yield and quality in direct seeded rice.

Kasu Pawar *et al.,* (2011**)** reported when Seed hardening with 2% $CaCl_2$ recorded significantly higher cotton yield (1844 kg /ha) followed by CCC 100ppm (1725kg /ha) via higher number of bolls per plant, boll weight and harvest index. The seed hardening with 2% $CaCl_2$ was more effective and economical in increasing yield and net returns.

Manjunath *et al.,* (2011) from the results seed hardening with 2% $CaCl_2$ recorded significantly higher yield hence this technique may be employed for boosting the productivity of chickpea under rainfed conditions.

Manjunath *et al.,* (2011) revealed in pre sowing seed hardening with $CaCl_2$- 2% improved yield of chickpea over the control. This simple technique may be employed by growers to realize the potential yield.

Mulsanti and Wahyuni (2011) reported that invigoration treatment with NaCl increased rice seed germination, vigor and growth rate of Ciherang variety, a lowland rice variety.

Parkavi *et al.,* (2011) reported that sesame seeds treated with potassium chloride 1% recorded higher values for germination percentage, root length, shoot length and vigour index.

Rajesh *et al.,* (2011) the present study was undertaken to evaluate different pre sowing treatment to hasten seed germination in *c.inophyllum*. Hence, it is recommended to use pre-sowing treatment such as scarification and alternate wetting and drying in cow dung slurry for raising of this species in large scale.

The yield parameters such as number of days for flowering, number of fruits per plant and fruit length and width also showed similar trend of growth parameters. The investigation clearly reveals that the biochemical properties of vermicompost (cow dung) play a major role in the growth and development of egg plant (Gandhi and sivagama sundari in 2012).

Narayanareddy and Biradarpatil (2012) found in per sowing treatment, seed treatment with two per cent $CaCl_2$ for 12h and dry back to original moisture content at room temperature recorded significantly higher germination percentage, seedling vigour index, field emergence, lesser days for per cent flowering and yield per ha followed by GA_3 treatment and water hydration.

Waghamore *et al.,* (2012) observed treatment with GA_3 (500 ppm) recorded the highest growth and yield parameters in both high and low vigour seeds of sesame, followed with $CaCl_2$ (0.05%) compared with control.

Ananthi *et al.,* (2013) the results of the study revealed that seeds hardened with $MgSO_4$ 100 ppm improved the germination (93 per cent) by three per cent compared to control (90 per cent), while that of designer seed (95 per cent) by five per cent. Likewise seedling vigour characters and field emergence also higher in seeds imposed with invigorative seed treatment.

Chitra devi karuppaswamy and Malliga perumal (2013) further, the could be the optimum concentration to induce seed germination and thereafter growth of the most intense mobilization of seed reserves that were stored in cotyledons occurred at germination and that the reserves were strongly reduced at the seedling growth stage.

Kumari *et* al., (2013) Further, consumers are becoming conscious and critical about the quality of food and by-product that affect their health though the toxicity depends to some extent of the type of food consumed.

La Dahamarudin *et al*., (2013) the results showed that the seed invigoration treatment employed affected seed germination of situ Patenggang and Limboto upland rice varieties.

Prakash *et al*.,(2013) it may concluded that seed hardening with KCl @ 1% followed by pelleting with pongam leaf powder @ 200g kg^{-1} is found to be the most effective treatment to grow rice under aerobic condition.

Rajesh *et* al., (2013) were undergoing the field experiment was conducted to find the variation in growth, biochemical and yield parameters of black gram under different concentrations (control, 1, 3, 5, 7.5 and 10%) of Panchagavya, and all the parameters were increased in 3% concentration.

Sankar Ganesh *et al*., (2013) reported the results, 5ppm concentrations of hormones were found to be the best for enhancing seedling growth in green gram. The result also emphasized that pre-sowing hardening treatment of cowpea seeds in IAA, GA_3 and IBA could significantly enhance their germination and seedling growth.

Srimathi *et al.,* (2013) were studied on organic seed fortification with *Jatropha curcas* and *Pongamia pinnata* using 'Panchagavya 'at one, two, three, four and five per cent concentrations with the three different soaking durations revealed that Panchagavya at 2 and 5% with the soaking duration of 16 and 8 h were superior than the control and other concentrations in terms of germination and seedling vigour for *Jatropha curcas* and *Pongamia* pinnata respectively.

Sujatha *et al.*,(2013) Hence, seed hardening is one of the physiological pre-sowing seed management practice given to seeds to resist drought or saline / sodic soils to boost up the yield and is also being practiced from time immemorial owing to the better performance among the agriculturists.

Babu *et al.,* (2014) The result shows that there is an increase in 10 to 13 per cent yield in the seed hardening treatment with $CaCl_2$ and CCC compared to control.

Seed primed with salicylic acid failed to emerge that might be due to toxicity effects of high salicylic acid concentration used and therefore the results are not presented. The oil contents of linola were obtained by Rooskhvisky's method using Soxhlet apparatus as described journal of Integrative Agriculture (Hafeez ur Rehman *et al.*,2014).

Krishna (2014) reported the Invigouration treatments showed significant variation for seedling dry weight, root shoot length and vigor index. The seeds treated with KNO_3 significantly produced higher quality parameters compared to seeds treated with Cytokinin (50ppm).

This may be due to favorable effect of $CaCl_2$ on seed germination and seedling vigour, growth and yield of cotton. Seed hardening with $CaCl_2$ (2%) also recorded highest benefit cost ratio (Patil *et al*., 2014).

Shailaja *et al.,* (2014) stated that the panchagavya can be an effective organic growth-promoter for small and marginal farmers.

sivakumar (2014) state that it is necessary to use natural products like Panchagavya to produce chemical residue free food crops and hence Panchagavya can play a major role in organic farming.

Ananthi *et al.,* (2015) state that the field emergence and seedling vigour characters also higher in seeds imposed with invigorative seed treatments.

Mallavarapu Geetha *et al.,* (2015) Among the treatments, it was found that the **T_7**, *i.e.*, treatment with vermicompost + panchakavya recorded maximum root length, shoot length, dry matter production, root volume, number of leaves seedling-1 and total chlorophyll content when compared to other treatments and control.

Sushila Kanwar *et* al., (2015) Thus, it is concluded that modification in surface configuration as ridge and furrow, plastic mulch and seed hardening with KNO_3 proved effective in enhancing grain yield under uncertain environment of the arid region and found to be the most effective treatments for meeting the production potential and profitability of pearl millet under rain-fed condition.

Bandana Bose *et al.,*(2016) The hardening treatments resulted a reduction in membrane leakage, shortened the days from sowing to 50% flowering, increased days to plant maturity after sowing and flowering and improved the yield attributes. Best performance was resulted from $Mg(NO_3)_2$ hardened set and that was followed by KNO_3 and distilled water hardened sets but control was always found inferior in timely and late sown crops.

Galahitigama *et al*., (2016) reported the results illustrated that some chemical such as $CaCl_2$, KNO_3can increase seedling performances under water stress conditions. When considering to the rice growth performances; Osmopriming with 2% KNO_3 increased leaf area/plant, number of leaves, number of effective tillers, plant height, shoot dry weight and 1000 grain weight compared to hydropriming control and other treatments.

Piyada Theerakulpisut *et al.,* (2016) based on growth parameters, priming rice seeds with all tested concentrations of KNO_3, mannitol and wood vinegar alleviated adverse effects of salt stress on growth compared with the non-priming and hydropriming treatments.

Roohul Amin *et al*., (2016) The results of the present investigations lead us to the conclusion that seed hardening with PEG-8000, $CaCl_2$and KNO_3 for 24 h showed maximum invigoration for improving vigor, growth and yield in wheat under drought stress. These hardening chemicals could be effectively used in wheat crop for the amelioration of drought under rainfed environment.

Future research may be more focused on advanced physical and biological methods of treating seeds alternative to chemical seed treatment. Seed treatment is an initial step in

raising a crop and therefore plays a major role in maintaining sustainable agriculture. The high cost of GM seed is a key factor in the high demand for and growth of chemical seed treatments. With the regulatory issues facing both granular and fumigant nematicides, there has been a great deal of focus on seed treatment uses of nematicidal and nematistatic products. A critical success factor for the seed treatment market was the development of a complete protection solution against various plant stressors in a single product that is grower-friendly, crop-friendly and environmental friendly (Geetika Singh *et al*., 2017).

CONCLUSION:

In conclusion of seed enhancement, a seed with chemicals and organic (botanical leaves extraction) hardened materials enhances the seed quality as measured by seed emergence, seedling length, seedling dry weight, seedling fresh weight with all growth and yield attributing characters in drought region and semi drought region, leading to savings on seed to the farmers.

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