Seed Pre-Treatment for Improving Germination in some Cultivated Plants

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Where there are no other known methods of propagation, propagation by seed is the rule in the case of many economic plants. In view of this feature, the study of the several aspects of seed germination begun with the dawn of the present century continues with an unabated interest. Valuable evidence has accumulated on several factors relating to germination viz., temperature, light, moisture etc. Interest in such problems as those of seed viability and light sensitivity led several workers to study the light and temperature relations of germination. Haberlandt (1875) was the pioneer to study over 70 agricultural plants and found that the optimum temperature and germination requirements of seeds varied considerably. He then correlated the time relations of germination with temperature and light sensitivity of seeds.

In subsequent years, it was found that dormancy and after-ripening of seed present a new set of problems in the study of seed germination. Dormancy and impermeability mostly associated with hard coated seeds acting as barriers in their germination have handicapped their rapid spread even when favourable conditions existed. It is known that dormancy in seeds is due to one or a combination of several factors, viz. impermeability of seed coat, mechanical resistance of the seed coat, impermeability to oxygen, immature embryo etc. Several methods in the past have been tried by investigators to overcome these barriers. The treatments that have been commonly used to hasten germination and overcome impermeability in hard coated seeds are scarification, dry-heat, freezing and thawing treatment with chemicals, placing under conditions favourable to after-ripening etc.

Among these, scarification or wearing down the hard seed coat is the common pre-treatment widely adopted. Rose (1915) found that hard-coated seeds of legume, *Hibiscus esculentus* and mustard could be made to germinate by being blown against needle points. In some seeds scarification is reported by Wolfe and Kipps (1926) to reduce their longevity.

Among chemicals, carbon-di-sulphide, ether, ethylene-di-chloride, sulphuric acid, etc., have been recommended to overcome low germination of impervious seeds by the softening of the seed coat. Jones (1928) found that the seed coats of ***Nelumbo lutea*** require a five hour treatment with sulphuric acid for facilitating their germination. Brown (1933) has reported that de-linting cotton seeds with sulphuric acid gives an increased rate of germination and 20 per cent increase in yield over the controls. Vapours of ethylene chlor-hydrin have been used to stimulate germination in hard-coated maple, oats, etc., by Deuber (1931) and Bramble (1932). A few other hormones have also been successfully tried by Mc Rostie and Hopkins (1938), Templeman (1939), Gracinin (1928) and others.

Certain physical means have also been effectively used by several investigators to induce germination in hard-coated seeds. Anderson (1931) obtained very high germination with seeds kept in darkness in dilute nitric acid. Germination in monkey flower ***Mimulus ringens*** was found by Hutchings (1932) roughly proportional to the intensity of light. Similar light sensitivity of seeds in germination has been brought out by Thornton (1936), Thompson (1935) and Flint (1934). Liquid air, partial pressure, alternation of temperature are other physical means that have been adopted by Bussee (1930) Harringron (1916), Midgeley (1926), Stewart (1926) Flemion (1931), Fivaz (1931), Moringa (1926) and a host of others to induce permeability in lucerne, celery, parsnip, flax, Bermuda grass etc. But certain abnormalities have been noticed by Busse and Burham (1093) in the use of the above treatments..

The literature on temperature relations of seed germination by Edwards (1932) gives a critical review of the optimal temparature relations and their significance in seed germination. Tang (1931) found that wheat seeds in general gave higher percentage of germination with higher temperatures, after which at still higher degrees lower germinations was recorded. Livingston and Haasis (1933), Barton (1932) Robbin and Petch (1932) are a few of the investigators who fixed up certain optimum temperatures for seed germination ranging between 30 to 25° C.

Most of the methods suggested by the above investigators stipulate the use of some complex technique and costly equipment. These are not possible for easy adoption on a popular scale, on account of the cost and lack of scientific knowledge about treatments. In order to overcome these drawbacks certain standard seed testing and germinating plants and other skilled establishments have been set up in foreign countries.

Initially a few of the above methods were employed to overcome impermeability and laboratory trials were underway with several hard-coated seeds of economic plants which are known to be poor germinators. Mainly heat by means of water at various temperatures was applied by steeping seeds for limited intervals of time generally not exceeding five minutes and the encouraging results obtained in their germination are described in this article.

1. *Lucaena glauca* (*Nagarikesari*). This is a small tree belonging to *Mimosoidae* having very wide distribution in this province. Its quick growth and response to pruning have made it suitable as a green leaf manure plant for paddy.

The seeds are dark brown and possess a shining hard testa or seed coat. They germinate very slowly and generally the germination does not exceed 20 per cent. After pre-treatment with hot water for five minutes at different temperatures the following germination was secured in repeated trials.

Temperature :	30°C	40°C	50°C	60°C	70°C	80°C	90°C	100°C
Mean germination per cent	24	30	37	56	78	74	3	...

Temperature between 70 to 80°C is found to cause the seed coat swell and facilitate over 70 per cent germination. Immersion for longer intervals does not induce further permeability to any appreciable degree and at higher temperatures the embryo is devitalized.

2. *Tephrosia purpurea : Wild Indigo or Kolingi or Vempali*. This is a green manure plant generally sown immediately after the harvest of paddy. The seeds are small, mottled, hard coated and are poor germinators. Realising this, Chandrasekhara Iyer (1940) has suggested sand papering for scarifying these seeds. Pounding the seeds with sand is also commonly advocated. By steeping these seeds directly in hot water at 90°C for five minutes, over 65 per cent germination has been secured within two days of the treatment, as against 10 — 15 per cent obtained with untreated seeds. The germination secured at different temperatures for the same interval of time is as follows.

Temperature : ...	70°C	80°C	90°C	100°C	Untreated
Mean germination per cent	51	41	74	45	13

Scarification by sand papering or pounding with sand have certain limitations. Steeping in hot water is feasible on a bulk scale and uniformity of treatment with minimum effort and labour merit this as a better treatment compared with the other methods. Where quick germination is needed through economic and feasible means on a large scale to utilize the rapidly decreasing moisture after the harvest of paddy, this method lends itself admirably in forcing maximum germination in a very short time.

3. *Crotalaria juncea* sunnhemp. This is one of the quickest growing green manure crops widely used for several agricultural crops all over the province. The seeds are kidney shaped, purple to dark brown

in colour and possess a shining coat of moderate thickness. Pre-treatment with hot water at 70°C for five minutes before sowing has given as much as even cent percent germination within a day as against 80 to 90 percent obtained with untreated ones.

The germination obtained at different temperatures for the same interval of time within 24 hours is as follows.

Temperature ...	70°C	80°C	90°C	100°C	Untreated
Mean germination per cent	96	86	81	4	84

To force almost cent percent germination without any deleterious effects in a single day, pre-treatment with hot water at 73°C for five minutes is an economic and feasible method to ensure maximum germination. Through such quick germination achieved by pre-treating the seed, the seedlings are enabled to establish immediately with the available moisture which rapidly decreases after crop harvets or under dry or rainfed conditions.

4. *Prosopis juliflora* (Mesquite). This is an introduced quick growing plant which possess the desirable qualities of a hedge. Its quick growth, response to drastic pruning, thorny nature and bitter taste of leaves enabling it to ward off the ravages of goats and cattle and rank it as one of the best hedge plants suited to our conditions, though exotic in origin. Its propagation has presented serious difficulties both on account of its hard coated seeds and the leathery nature of the fruit impeding rapid seed extraction.

The pods are spongy with thick juicy pericarp. This can be softened by treatment with 1 : 4 sulphuric acid added just to wet the seeds and after 15 minutes the acid is diluted with enough water to cover or soak the pods completely and this is left to stand overnight. During this interval the acid corrodes and softens the pericarp without injuring the seeds enclosed in it. In one drying, the pounding is facilitated and the seeds are easily extracted. It has been found that the acid treatment is absolutely harmless and not inhibiting germination and at the same time costing not more than one anna per lb.

Direct pre-treatment of the seeds with hot water is not effective as scarification. Nambiar (1944) has stated that germination could be highly improved by shaking the seeds with sand in metal containers. About 65 per cent germination can be secured by this method within three days as against 10 — 15 per cent obtained without pre-treatment. Seeds scarified with sand when treated with hot water at 70°C for five minutes give generally ten per cent higher germination than that secured with mere scarification. Within three days it is thus possible to secure over 75 percent germination by adopting the above two methods.

5. *Delonix regia* (*Gul Mohr*). This is an avenue tree found all over the province. The seeds are cylindrical, long, hard and tapering at ends. Treatment of these seeds in hot water for five minutes at varying temperatures gave the following germination within a fortnight.

Temperature ...	60°C	70°C	80°C	85°C	90°C	100°C	Untreated
Mean germination per cent	37	48	69	75	44	49	24

Direct steeping in hot water between 80 to 85°C gives about three times higher germination than that of untreated seeds within a fortnight. The testa or seed coat wears down into thin wavy films and facilitates the absorption of water and the quick germination of the embryo.

6. *Delonix elata.* This is an avenue tree found largely in the several regions of this province resembling almost *Delonix regia* and popularly known as Chittikeswari in Telugu. The seeds are flat, hard and possess dull metallic lusture. With similiar pre-treatment in hot water for five minutes at varying temperatures the germination obtained is tabulated below.

Temperature ...	60°	70°	80°	90°	100°C	Untreated
Mean germination per cent	36	44	68	84	49	40

Within a fortnight, germination about twice that of the untreated seeds could be secured by directly steeping the seeds in water at 90°C for five minutes.

7. *Phyllanthus emblica* (Indian Gooseberry). This is an useful plant found scattered all over this province. The fruits are reputed to be the richest source of Vitamin C. The seeds are hard, angular, and brown in colour and are poor germinators. The seeds are extracted by drying the fruits in sun light for some days, when the carpels dehisce and liberate the enclosed seeds. The seeds require about two months storage after harvest for 'after ripening'. Attempts to induce germination in this period failed to achieve any success. Subsequently treatment of the seeds with hot water between 75 to 85°C for five minutes, over 80 percent germination was secured within ten days as against about 25 percent obtained with untreated seeds. The seeds vary very highly in their capacity to germinate and prior steeping in cold water is necessary to reject immature and sterile ones that float.

8. *Mimusops hexandra* (Pala). This is an evergreen wild fruit plant. The seedlings are used as a rootstock for sapota (*Achras sapota*) and the fruits are edible. The seeds vary in size and colour and the cotyledons are enclosed in a hollow thick seed coat. The seeds require over a month's 'after ripening' after extraction. Split seeds showed over ten percent germination although 15 percent were damaged in spliting the seeds with a wooden hammer. Steeping the seeds in water for five minutes at 80°C induce about 10 per cent germination within a fortnight as against one or two per cent obtained with untreated seeds.

9. *Zizyphus jujuba* (Ber). This is a hardy fruit plant found scattered all over the province and requires very little attention in its maintenance. Select and choice plants are generally propagated by budding on seedlings. The fruits are round and the endocarp enclosing the seeds exceeds one fourth inch in thickness. They do not give more that 2 per cent germination even after two months. The seeds are extracted by breaking the stony coat or endocarp with an iron hammer against a hard surface. About 30 per cent damage or loss is inevitable even with careful extraction. The extracted naked seeds when soaked in water at varying temperatures, the following germination was obtained within a month.

Temperature ...	60°	70°	80°	90°	100°C	Untreated
Mean germination per cent	6	39	9	3	...	2

Pre-treatment of the extracted seeds with hot water at 70°C for five minutes gives a high percentage of germination as against a meagre percentage obtained with the hard stony coat in tact.

10. *Medicago sativa* (Lucerne). This is widely used in all countries as a fodder crop and is generally fed to horses and milch cows. The seeds are minute, reniform and fairly hard coated. Midgely (1926) has reported that these seeds germinate better when kept in moist condition for several months. Several other methods have also been suggested by other investigators to overcome impermeability in lucerne.

By steeping the seeds in warm water at 50°C for five minutes, over 50 per cent germination can be secured within four days as against 30 — 40 per cent obtained with untreated seeds. At higher temperatures germination is inhibited and the embryo does not withstand the heat.

Summary and Conclusions

Seeds of some economic plants subjected to heat pre-treatments at varying temperatures for an interval not exceeding 5 minutes, give different response in germination; in all cases the treated seeds showing greater germination per cent than the untreated ones.

The table below gives the summery of performances of the economic plants tried here.

Name of plant.	Temperature of water in C.	Time of treatment	Mean germination per cent		Period or Interval.
			Treated	Untreated	
		Minutes.			
1. Lucaena glauca	70	5	78	24	10 days
2. Tephrosia purpurea	90	5	70	13	2 „
3. Crotolaria juncea (Sunnhemp)	70	5	96	14	24 Hours
4. Prosopis juliflora (after shaking with sand)	70	5	78	12	3 Days.
5. Delonix regia	85	5	75	24	14 Days
6. Delonix elata	90	2	40	14	14 „
7. Mimusops hexandra (Pala)	80	5	10	14	14 „
8. Phyllanthus emblica (Indian Gooseberry)	80	5	82	20	10 „
9. Zizyphus jujuba (with naked seeds)	70	5	39	2	30 „
10. Medicago sativa (Lucerne)	50	5	52	35	4 „

II. Optimum germination is obtained with treatment for five minutes in water ranging between 70 to 80° C in many of the plants reported here.

III. At higher temperature over 80° C, only wild indigo and *Delonlx elata* have shown better response in germination than at lower temperatures indicating that the thicker the seed coat, the higher is the temperature required to induce maximum permeability.

IV. Still higher temperatures between 90 to 100 C, or at boiling point of water, the seed coat looses its resistance and in many seeds very poor germination has been recorded; this temperature being detrimental to the vitality of the embryo.

V. Temperatures between 50 to 70° C though induce better germination than the control are not sufficient to induce maximum permeability.

VI. Heat pre-treatment through water induces the seed coat to swell and causes permeability and promotes the development of the embryo. Simultaneously it facilitates the penetration of the radicle through the softened seed coat.

VII. In some hard coated seeds, heat treatment by itself fails to induce permeability but accelerates the pace of germination after scarification. In *Prosopis juliflora* prior scarification is necessary by grinding with sand and further treatment with hot water increases the pace of germination. In *Zizyphus jujuba* and *Mimusops hexandra* intermediate fruit coats are stony and do not allow moisture or the expansion of the embryo. The breaking of this coat is necessary prior to heat treatment to allow the ingress of water and the development of the embryo.

From the foregoing, it is clear that heat through water at varying temperatures is a feasible means of inducing permeability in hard-coated seeds of some economic plants. Otherwise, in these seeds germination fails to occur normally till water penetrates in to the seed coat. The pace of germination is generally quickened with the breaking of the dormancy and impermeability induced by heat. Seed permeability in several other hard coated seeds not tried so far is also likely to be facilitated by such pre-treatment resulting in quicker and higher germination. Depending upon the thickness of the seed coat, the harder the seed coat, the higher is the temperature required for inducing permeability. In still harder seed coats, breaking of the fruit coat or other structure which acts as a barrier is needed. Optimum permeability without any deleterious effects on the embryo is generally secured with five minutes treatment irrespective of the range of temperature. At higher temperatures beyond 80° C, generally treatment for periods longer than five minutes has been found to be definitely detrimental to the embryo. At temperature below 80° C, treating the seeds beyond five minutes period does not induce appreciably higher permeability or greater germination. This has been already indicated by the author with *Lucaena qlauca* (1948). The emergence of the radicle penetrating the seed coat, has been taken as the sign of germination. In field trials, longer periods are required as the seedling is seen only when the germination phase is nearing its end.

Wherever there was low germination at temperatures over 80° C, in general, it was observed that the embryoes are devitalised or killed due to heat shock and in many cases at 100° C, or boiling point of water, most of the seeds get cooked. Proper care and adequate caution are therefore required in observing the temperature and in adhering to the limits specified which generally does not exceed 5 minutes for securing maximum germination without any untoward effects. The seedlings from heat treated seeds were found in all cases coming up like the normal plants and injurious effects if any resulting in the death of the embryo or intermediary effects as set back in growth or wilting of the seedling are not seen.

At present there is universal shortage of all commodities. Seeds are priced high and are not available in adequate quantities especially when a drive for more planting and increased food production is a-head. It is felt that by adopting the above methods, more plants can be secured in a very short time out of the available and wastage in seed can be eleminated through such an exploitation. In the case of green manure crops which are generally sown after crop harvests or as intercrops under rainfed conditions, utilisation of the rapidly decreasing moisture in the soil, is an essential requisite for successful crop production. The above methods of seed pretreatment remove the erstwhile handicaps and facilitate in the case of green manure crops like Sunnhemp and Wild Indigo maximum germination in as short an interval as possible and the successful establishment of the plants before the moisture dries off. It is hoped on account of the simplicity, and feasibility, the above methods will be widely adopted by the agriculturists.

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