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Impact of Various Physical and Physiological factors on Seed Germination, Seed Deterioration, Quality and in Storage: A Review

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ABSTRACT

Seed germination and seed quality parameters play an important role in crop production and crop multiplication. And development of several standards for germination and seed testing is the basic requirement in seed production, crop improvement and crop multiplication. To set the testing protocol is the basic requirement because seed is the key factor of agriculture without having a good seed our agriculture system is failed. That's why the standardization of technique and production methods is very important for a successful production. In medicinal plants the standardization of protocols are not easily available.

Key words: *Seed germination, Seed deterioration, Seed storage*

Introduction

Pistacia khinjuk (Kakra-Singi, Kakroi, Sans. Chakra) Deciduous trees, with rough, gray bark. Leaves alternate, paripinnate or imparipinnate, 15-20cm long, young ones pinkish- red; leaflets 4-6 pairs, opposite or sub opposite, minutely petioluled, 8-15×2.5-3.5cm, lanceolate, long acuminate, entire, coriaceous, glabrous, base oblique; lateral nerves about 20 pairs. Flowers small, apetalous, unisexual; male flowers on 5-10cm long compact, pubescent red panicles; female flowers on 10-25cm long, lax panicles; somewhat pinkish-red flowers appearing with or just before the young leaves. Calyx 3-5 paritite and fused in male flowers; free in female flowers. Stamens (5-7) are present on a small disc and red large anthers are present, Ovary sessile, 1-called; styles 3, cohering near the base. Drupes 3-5 mm across, irregularly globose, oblique, pink. Flowering occurs in March-April and appearance of Fruits occur in-June to August.

Rare; miscellaneous, exposed localities of sub-Himalayan tracts, ascending to 2500 m Kaleshwar, Dugadda, GUH 8962 (Gaur, 1999). Timber used in house construction, carving, furniture manufacture, farm implements, musical instruments and thatch. The timber can also be used in veneer and plywood manufacture. Medicinal usage: *P.khinjuk* galls are used in traditional medicine to treat coughs, asthma, diarrhea, dysentery, fever, vomiting, appetite loss, nose bleeding, snake bites and scorpion stings. The plant extracts are used in treating livestock diseases (Orwa *et al.*, 2009)

Embelia tsjeriam-cottam (vaya-vidang, vidhanga,

(Assistant Prof.)

sans. Vrishanasana) rambling shrubs or trees, with scandent branches and dark-brown bark. Leaves obovate-oblong, lanceolate or broadly elliptic, 7.5-16×3.5-10cm, shortly acuminate, undulate, more or less serrulate in the upper half, rusty-pubescent beneath; lateral nerves 6-9 pairs; petioles glandular, channeled. Flowers small, 4-3 mm across, palegreenish, tinged with purple in the centre; usually dioecious, in axillary or extra axillary, pubescent racemes. Calyx free, deeply 5-lobed, persistent, Petals 5, free, oblong, reflexed, puberulous. Stamens 5, adnate to the petals. Fruits drupaceous, about 3mm across, bright red or purplish, 1-seeded. Flowers; July – September Fruits; December- February Common; moist, shady places, grassy slopes, way sides, 800-2000 m, Kaleshwar, Bharsar, GUH 1518. Montane and submontane Himalaya, 600-2000m; C. Nepal, china, Africa, Arabia.Fruit used as laxative in colic, sometimes anthelmintic, traditionally with the name of "Bayabirang"; flowers useful in apiculture as bee-forage (Gaur, 1999). The fruits of *E. tsjeriam* are used to treat worm infestation, anaemia, oedema, ringworm and other skin diseases, fever, anorexia, urinary calculi, and vomiting (Somashekhar and Sharma, 2002).

Seed Germination and factors involved in seed germination

On International level, there are lots of people performed investing on seed dormancy, Germination, effect of temperature, light, and soil on seedling emergence, and seedling Growth of medicinal plants. Rokaya and Münzbergová (2012), worked on effect of light, temperature and seed mass on germination of two species of the Himalayan rhubarb. Teimouri *et al.* (2013), studied on seed germination and breaking of seed dormancy techniques for endemic *Hymenocrater platystegius* Rech.f. of Khorasan Razavi province, Iran.

Ferdousi *et al. (*2014), performed research work on seed germination behavior of six medicinal plants from Bangladesh. Jamian *et al.* (2014). Physical dormancy is the most phylogenetically restricted class of seed dormancy and it is of special ecological significance as it increases the life span of seed significantly (Parihar, 2003). Recently Kandari *et al.* (2007) studied the work on effect of pre-sowing treatment on seed germination. Giri and Tamta (2012) in *Angelica glauca* Edgew, *Pleurospermum angelicoides* and *Hedychium spicatum* Kandari *et al.* (2008), carried out the work on Effect of pre-sowing, temperature and light on the seed Germination of *Arnebia benthamii* (Wall. Ex G.Don): An endangered medicinal plant of Central Himalaya, India Chauhan *et al*. (2009), Search the information on Assessment of Compatible Substratum for *Andrographis paniculata* standard seed germination testing. Korade and Fulekar (2009), Suggested, Effect of organic contaminants on seed germination of *Lolium multuflorum* in Soil.

Vashistha *et al.* (2010) studied on evaluation of emergence and vigor of Ashwagandha (*Withania somnifera* Dunal) seedlings under the influence of Sodium Hypochlorite and different micro-environmental condition. Vishnoi *et al.* (2010), give the information on Effect of Different Sand and Soil Ratios on the Growth of *Terminalia arjuna* W. & A. Kumar and Sharma (2012), carried out work on Effect of Light and Temperature on Seed Germination of important medicinal and Aromatic plants in north western Himalayas. Parmar *et al.* (2012), research work on Seed Germination and seedling Analysis of *Saussurea costus* Royle Ex Benth. In high and Low Altitudinal Villages of District Uttarkashi

Bhosale and More (2013), Worked on Response of *Withania somnifera,* (L.). Mariappan *et al*., (2014), carried out work on Effect of liquid biofertilizers on enhancement of germination in stored seeds of *Pongamia pinnata.* Germination studies among different populations provide helpful clues on genetic makeup of the species and its existence in the natural population (Baskin and Baskin, 1998).

Vashistha *et al*. (2010) deals with improvement in seed germination of *Elaeagnus rhamnoides* (L.) A. Nelson collected from different parts of Garhwal Himalaya upon treatment of Gibberellic acid (GA3) in laboratory condition. GA_3 (200 ppm) significantly improved germination in two populations viz., Raigari and Rambara of *E. rhamnoides*. Mean germination time (MGT) was also reduced by GA3 treatments in all the populations as compared to control. A high degree of variation with regard to the germination percentage in different populations is recorded.

Knowledge of such variations in germination of species is essential for selection of best provenance of seeds (Jayshanker *et al.,* 1999). Reports suggest that populations of a species differ in their germination responses (Perez-Garcia *et al.,* 1995). Factors such as, mother plant environment (e.g.nutrient, light and water) (Fenner, 1991; Baskin and Baskin, 1998) studied the position of the seeds on a plant influence the germination response of the seeds. Besides these, latitude and elevation also play an important role in affecting germination responses among different populations. Seeds developing at different positions on the mother plant may not have the same germination requirements (Baskin and Baskin, 1998).

Gibberellic acid is the most commonly used hormones for promoting seed germination and is particularly considered responsible for mobilization of nutrients (Hartmann and Kester, 1989; Kumar *et al.* 2006). An in-crease in seed germination in different prove-nances of Himalayan cypress (*Cupres sustorulosa* Don.) from Uttarakhand Himalaya by GA_3 treatment was recorded by Rawat *et al.* (2008). Nautiyal *et al.* (1985) observed seed germination in two Aconitum species and revealed that, seed treated with GA3 not only in-creased germination percentage but also resulted in an enhanced hypocotyl length. Butola *et al.* (2007) found that GA3 (150 mM) was effective in stimulating germination (70%) and reducing MGT (17 days) over control in *Hypericum perforatum* L. 2009).

In a crop's life cycle, the time from seed sowing to seedling establishment is considered a vital phase, which decidedly influences the final yield and postharvest seed quality (Wurr and Fellows, 1983).

Saumya (2014) Embe Exogenous application of IBA and NAA has a significant positive effect on the percentage of rooting. Rooting ability of cuttings was mostly influenced by the type of cutting, retention of leaves and time of the year in which cuttings were taken. Semi hardwood cuttings with two or three leaves, treated with IBA in 3000 mg/l concentration in season I (January – April) appears to be a successful method for vegetative propagation (100% rooting) for producing sufficient number of propagules of this species. Significant increase in number of new root, leaves and shoots and length of roots was recorded in stem cuttings treated with 3000 mg/l IBA.

This plant is reported as vulnerable in Tamil Nadu and Karnataka and as threatened in Kerala. The main threat of this plant is its unsustainable and indiscriminate harvesting for commercial purposes. Habitat loss, Jhum cultivation, forest fire and agriculture expansions are also some factors for its decrease in population. The regeneration from seedling of this plant is very poor. The embryos of *E.ribes* are very small when present and most of the seeds are abortive. For the survival and growth of *E.ribes* specific habitat conditions are essential. Regeneration of *E.ribes* is very poor and slow. *E.ribes* acquired high trade value and its demand in the local market is greater than100 t/yr. During 1990–2000 the demand for *E. ribes* increased enormously and the export increased to 250 t/yr 5. Due to over demand this species extensively wild harvested from the protected and conserved areas also. So the conservation of this important medicinal plant requires special attention.GA3 increased seed germination (32%) at the first two days, thus confirming its role as a stimulatory agent. 30 min pre-sowing with NaHClO3 decreased seed germination (up to 34%), contrasting with the stimulatory effects reported by others (Hsiao, 1979; Ho *et al*. 1995; Nadeem *et al.*, 2000); this may be related to the type of seed (plant species) and/or concentration/time depended. These stimulatory treatments may help germinating seedlings early, providing them higher competitive ability (Zhang Maun, 1990) and hence reducing chances of their mortality.

Seed priming treatments (pre-sowing seed treatment) using moist-chilling, growth regulators (e.g. gibberelic acid applications; GA3) and plant derived smoke compounds (el-Dengawy, 2005) magnetic fields (Ahmet, 2003) and salts such as KNO3 have been effective in improving seed germination at low and high temperatures (Sachs, 1977). Seed maturation stage can also be an influential factor in germination performance at low temperatures and response to priming treatment. In general, mature seeds tend to show a better germination performance at stress temperatures than those of earlier and later harvests, while advancement obtained by priming was greater in earlier harvests (e.g. premature seeds) (Olouch, 1996). Failure of the seed germination under optimum conditions does not conclusively prove that the seed is not viable. The other possibility remains that it may be dormant. The most reliable, quick and easiest method to find out the viability and dormancy is the tetrazolium test. By this method we find out the actual conditions of the seeds.

Kandari *et al.* (2007) the effect of a plant growth regulator - GA3, (100, 200, 300 ppm), temperature regimes (15, 20, 25 ^{0}C) and photoperiodic conditions (light and dark) were examined for enhancing and synchronizing the uniform germination in two endangered and commercially important medicinal herbs of the Himalayan region namely Angelica glauca Edgew and *Pleurospermum angelicoides* (Wall.

Ex DC.) Benth. ex C.B. Clarke. The tetrazolium (TTC) staining method indicated that viability of freshly collected seeds was good but it declined under storage conditions at 40C with time. In A. glauca, seeds treated with GA3 at 100 ppm enhanced germination significantly ($P<0.05$) under light conditions at 25 °C. However, in P. angelicoides GA3 did not influence seed germination as compared to control at 25 °C under light conditions. Mean germination time was recorded lowest under all treatments at 15 °C for both the species. The present study indicates that higher temperature (25 °C) and light have a positive relationship with seed germination of these species even under no pretreatments. Pretreatments have only marginally improved the seed germination of the species and all treatments used in the present study are cost effective for mass propagation of these species. Low seed viability may be one of the reasons for the poor germination in nature. Difference in seed germination rate has been reported in different populations and variants of the same populations of *Podophyllum hexandrum* and variants of the same populations of this species.

In this investigation *A. glauca* and *P. angelicoides* showed decline in germinability at the end of twelve months storage at room temperatures (25 ^{0}C). There are variations in the germinability of different rhizomatous herbs of the Himalayan region. Freshly collected seeds of Aconitum hetrophyllum and Aconitum balfouri had high viability, which decreased following storage at 4 ^{0}C for 6 and 12 months. It is reported that the seed storage at 4 °C could maintain optimum moisture and thus remain viable for some time, rather than those stored at room temperature for a short period (Nautiyal, 1985) studied that GA3 under all concentrations did not improve germination significantly. But most of the pretreatments carried out in the present study showed improvement in seed germination and reduced mean germination time for both the species.

Seed germination can also be regulated by the conditions prevailing during seed formation as well as by hereditary factors. In all cases increase in germination percentage reduces MGT. The present study reveals negligible effects of GA_3 on A. glauca and *P. angelicoides*. The poor response of GA_3 may be due to the presence of naturally occurring inhibitors, which may not be suppressed by the application of GA, Hartmann and Kester (1989). Ganga Datt and Chauhan (2017) studied the effect of storage behaviour of *M. esculenta* seeds on germination, seedling emergence and suitable seed storage conditions to retain viability were standardized. The five storage containers i.e., earthen pots (C_1), plastic jars (C_2), canvas bags (C_3), polythene bags (C_4) and tin boxes (C_5) and four temperature regimes The interaction effect of earthen pots under 0 ± 1 0C temperature regime (C_1T_2) maintained significantly ($P<0.05$) maximum germinability after 2 months (53.75%) followed by C_2T_2 and C_3T_2 (51.00 and 46.25%, respectively) as compared to other storage conditions and minimum germinability showed in 6 months old seeds stored in tin boxes at 10 ± 1 ^{0}C (C_5T_4) as 1.75%.

However, it was found in some studies that age of the stored seeds in the storage periods influence germination rate many plants species. Seed stored at low temperature maintained their seed viability, vigour and also may reduce seed metabolism rate including respiration, decreasing oxidation and minimizing deterioration (Martinkova *et al.,* 2006).

Recently experimental works on seed dormancy, Germination, effect of temperature, light, and soil on seedling emergence, and seedling growth of medicinal plants have been carried out by various workers. Kandari *et al.* (2007), carried out research work on effect of pre-sowing treatment on seed germination of two endangered medicinal Herbs of the Himalaya (*Angelica glauca* and *Pleurospermum angelicoides*. Kandari *et al.* (2007), carried out the work on Effect of pre-sowing, temperature and light on the seed Germination of *Arnebia benthamii.* The effect of temperature and light on the germination of seeds was investigated with various pre sowing treatments of water and GA_3. Germination was found to be temperature and light dependent. Though the seed viability was 82% as determined by Tetrazolium staining, maximum germination of 100% was obtained only when the seed was soaked in 100 ppm GA_3 solution for 24 h and incubated for germination at 25 °C constant temperatures in 12 h light conditions. All the treatments at 25 °C and presoaking in 100 ppm GA_3 and incubation at 15 and 25 °C seems to be effective treatments and could be easily adopted by the potential farmers for economic cultivation of this species. Chauhan *et al.* (2009), carried out investigation on assessment of compatible substratum for *Andrographis paniculata* in a seed germination testing. The seeds were collected and stored for six months at optimum temperature. Four substrata namely filter paper, top soil, saw dust and river bed sand was collected for the experiment. The 16 days test showed varied germination index and number of secondary roots. The result showed that the sterilized filter paper has proved most effective and compatible substratum for the *Andrographis paniculata* standard seed germination test. This led to uniform and quick germination with proper secondary roots and primary leaves.

Korade and Fulekar (2009), worked on seed germination of *Lolium multuflorum* in Soil. The seed germination trials have relevance in selection of the plants for their prospective use in phytoremediation. The effect of several environmental factors on germination of medicinal herb *Centella asiatica* was investigated by Anjana Devkota and Pramod Kumar Jha, (2010**),** Freshly harvested seeds of *C. asiatica* did not germinate even after gibberellic acid treatment and exposure to different treatments with light qualities, while two-three months old seeds exhibited germination (82%) without pre-treatment at warm environment (25 -30 °C). Vashistha *et al.,* (2010) have evaluated the emergence and vigor of *Withania somnifera* Dunal seedlings under the influence of Sodium Hypochlorite and different micro-environmental condition. They examined the effect of different micro-environmental conditions (open, glasshouse and net house) and pre-sowing treatments of Sodium Hypochlorite ($NaHClO_3$: 5 and 10-minutes) on seedling emergence, growth and biomass. The seeds treated with $NaHClO_3$ (5-minutes) showed maximum emergence in glasshouse condition (76.67%), which was significantly ($P<0.05$) higher than other conditions.

Giri and Tamta (2012), examined the effect of various pre-sowing treatments on seed germination of an important and vulnerable high value medicinal plant, *Hedychium spicatum* with different plant growth regulators (PGRs) and nitrogenous compounds under different conditions. Ananthi *et al.* (2012), have conducted the work on Factors influencing seed dormancy and germination of *Trichosanthes tricaspidata.* Among the various methods evaluated, hormone treatment proved to be efficient in breaking the dormancy (30.6%) followed by cow dung treatment (12%) and osmo-priming with Potassium dihydrogen phosphate treatment (5.3%). Heat and scarification (mechanical and chemical) treatments did not enhance the germination activity of seeds. Thus, seeds treated with GA3 or cow dung could be sowed in to the forest to enhance the population of this vulnerable species.

Kumar and Sharma (2012) have worked on effect of light and temperature on seed germination of important medicinal and aromatic plants viz, *Steria rebaudiana*, *Salvia sclarea* and *Tagets minuta* in sand and filter paper. The treatments comprised of two factors viz, light and temperature regimes under room temperature, 20 °C and 10 °C. Maximum seed germination was observed in the seed those were placed for two days open in room temperature and then placed at 20 °C in continuous light in all the three plants species. Parmar *et al.* (2012), carried out research work on seed germination and seedling analysis of *Saussurea costus* in high and low altitudinal villages of district Uttarkashi. The high altitudinal region (within polyhouse) of the Himalayas, contains the highest percentage of seed germination and survival percentage while in low altitudinal village low germination and survival percentage were noticed.

Experimental work on the effect of light, temperature and seed mass on germination of two species of the Himalayan rhubarb growing in high altitudes has also been conducted by Rokaya and Münzbergová (2012). An overall percentage of germination was recorded higher for *R. acuminatum* than for *R. australe* both in light and complete darkness. They have recommended that seeds of both species will germinate better if shifted to lower altitudes where temperatures are higher than at their actual habitats. Bhosale and More (2013) have taken two soils from different locations in Satara district to observe germination and vegetative growth in *Withania somnifera*. The seeds of *Withania somnifera,* were harvested and used for further investigations. Different locations of Junnar taluka showed different response to germination and vegetative growth. From present investigation it can be concluded that soil with alkaline properties was more efficient for germination and growth of *Withania somnifera,* Dunal. than acidic soil.

Seed germination and breaking of seed dormancy techniques for endemic *Hymenocrater platystegius* was conducted by Teimouri *et al.* (2013) with 4 replications in a completely randomized design. Seeds were subjected to different treatments including 27 various levels of potassium nitrate in different concentrations, embryo culture, cutting by scalpel, holing by needle, scarification in sulfuric acid 98% in various time intervals, various magnetic field, and hot water in various time intervals, stratification, Sodium hypochlorite, leaching, scratching by sand-paper, soaking with water and chilling. Overall, the effect of alternate temperature treatments (15.25ºC) on seeds that affected combination treatment were showed the highest germination percentage (92%) and best Mean germination time (8.7 days). Ferdousi *et al.,* (2014) have also conducted work on seed germination behavior of six medicinal plants from Bangladesh, namely *Adenanthera pavonina*, *Helicteres isora*, *Murraya paniculata Psoralea corylifolia, Uraria lagopodioides,* etc. Seeds were not germinated in *Helicteres isora* indicating that seeds are not suitable for propagation, however, propagation through stem cutting in this species revealed that plants flowers and set fruits in the same year and take only six to seven months.

Jamian *et al.* (2014), have investigated effects of elevated temperatures on seed germination and seedling growth in three medicinal plants. Results indicated that temperature affected germination percentage and germination rate of these medicinal plants. Kanta and Rao, (2014), established parameter on effect of water stress on seed germination and seedling growth in six medicinal plant species in tarai region, Uttarakhand. The influence of water stress (0, -5, -10 and -15 bar) on seed germination and seedling growth were examined under laboratory conditions with triplicates. The per cent seed germination was maximum and minimum in 0 and – 15 bar water stress, respectively in all the species. Mariappan *et al.,* (2014), carried out work on effect of liquid biofertilizers on enhancement of germination in stored seeds of *Pongamia pinnata.* Effect of biopriming of seed with liquid biofertilizers (*Azospirillum* and *Phosphobacterium*) was studied in stored seeds of *Pongamia pinnata* to improve the seed and seedling quality characters. The result revealed that seed treatment with liquid *Phosphobacterium* at 1.5% recorded. Soon the bases of above review we find that for seed germination and deterioration several factors are responsible, on the basis of that we find the solutions for preservation of genetic material for further multiplication of various species.

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