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SEED DORMANCY AND SPECTRUM OF ECOLOGICAL ADAPTABILITY

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Seed dormancy can be easily visualized in wild legumes like *Alysicarpus* spp., *Melilotus alba, M. indica, Indigofera astragalina, I. glandulosa, I. linnaei, I. linifolia, Medicago lupulina, M. denticulata, Clitoria ternatea, Apocynaceous* member *Rauvolfia serpentina* and *Caesalpiniaceous* member *Cassia obtussifolia* and *Cassia tora*. The causes, removal and ecological adaptability of seed dormancy have been discussed.

INTRODUCTION

The seeds whose germination are inhibited owing to some internal limitations are known as dormant (Choudhury *et al*., 2009). For such seeds to germinate, they must be hydrated in conditions which encourage metabolism such as suitable temperature and presence of oxygen. Seed germinations are initiated with water uptake and terminate after elongation of embryonic axis This phenomenon includes numerous events such as hydration of protein, structural changes at sub-cellular level, respiration, macromolecular synthesis and cell elongation. All these events transform a dehydrated resting embryo into one having vigorous metabolism culminating in growth.

Rest is another name of dormancy. Imposed dormancy is quiescence which is the inability of a viable seed to germinate because the environmental factors required for it are not available.

There are two types of dormancy, one is primary dormancy which is due to some intrinsic factors related to seeds as against secondary dormancy. Secondary dormancy is due to some changes during storage such as *Taxus* and *Fraxinus*. These seeds may germinate immediately after they are shed off and environmental conditions are favourable e.g., *Rauvolfia tetraphylla*. They do not germinate if they are stored.

Causes of seed dormancy

Hard and Thick seedcoat

Seeds of many wild legumes are hard, resistant to abrasion and are covered with a wax like layer. Suberised strophioler cleft, some times may be observed. Special cells may block hilum and chalaza.

The hard and thick seedcoat inhibit entry of water and oxygen. Respiration is repressed due to unavailability of oxygen and increased concentration of CO_2 in the interior of the seed. Thus, germination does not occur. Gresta *et al.,* (2011) have worked on hard coat imposed dormancy in legume seeds.

Immature embryo

In *Ginkgo biloba*, *Anemone neumorosa* and *Caltha palustris*, there is immature embryo when seeds are shed. Thus, there is no possibility of germination without complete development of embryo.

The members of Orchidaceae have similar characteristics. Sometimes the embryo is fully developed at the time of seed shedding but requires considerable growth before it is able to form a seedling. The time required for maturity of embryo varies from few days to several months. Several morphological, anatomical and biochemical changes may occur during this after-ripening period.

Germination inhibitors

Parascorbic acid and coumerin (an unsaturated lactone) are germination inhibitors and are present in fruit pulp or seedcoat. Glumes are the reason of dormancy in a number of cereals. In *Avena fatua*, the hull does not allow the leaching of inhibitors present in caryopsis. Fruit pulp is the site of germination inhibitors in *Momordica charantia*. Such inhibitors are removed after rubbing of ash over the seed. Other germination inhibitors are cyanide, dinitrophenol, azide, chloride, hydroxylamine, fluoride etc. Growth retardants like Amo 1618, cycocel and phosphon-D also inhibit germination.

Abscisic acid is also a germination inhibitor and its content and dormancy can be correlated in *Fraxinus americana*.

Temperature requirements

Seed germination is a physiological and biochemical phenomenon. Some seeds require either high or low temperature before germination. There is requirement of low temperature in presence of O_2 in moist condition for weeks to months for germination in *Polygonum* spp. and some conifers. Alternating high and low temperatures are sometimes required.

Specific requirement of light

Specific light requirement can be noticed in some seeds, e.g., *Lactuca sativa* which germinates in red light. The seeds of *Nigella sativa* germinate in dark.

High osmotic concentration

This prevents germination in *Atriplex*. The seeds germinate only when some solutes come out from seeds due to optimum rainfall.

Methods of breaking seed dormancy

There are several techniques to break the seed dormancy which are as below :-

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Mechanical scarification

It is done by abrasive papers, sand, needle or blade, shaking of seeds is also helpful if strophioler plug is suberised. e.g., *Crotalaria*.

Needle pricking or partial cut of seedcoat removes dormancy in *Clitoria ternatea*. Sinha *et al.* (2008) who studied *Rauvolfia serpentina* removed coat dormancy by removing only half coats by blade. Care was taken to protect the embryonal portion.

Chemical scarification

It is done by conc H_2SO_4, HCl, HNO_3, alcohol, thiourea and ascorbic acid. Sulphuric acid is the best one for chemical scarification.

Kumari (1993) and Archana (1996) worked on seed dormancy in *Indigofera linnaei*, *I. linifolia*, *I. astragalina*, *I. glandulosa*, *Medicago denticulata*, *M. lupulina, Melilotus alba* and *M. indica* in the Department of Botany, Patna University.

All the species were collected locally except *I. astragalina* and *I. glandulosa* which were procured from Division of Plant Industry, Canberra city, Australia.

Both the workers treated the seeds with conc. H_2SO_4 for varying periods ranging from 5 to 40 minutes.

All the species mentioned above showed dormancy. In control, *I. linnaei* showed 18%, *I. linifolia* 3%, *I. astragalina*, and *M. denticulata* 8%, *Melilotus alba, M. indica* and *M. lupulina* 10% germination.

Twenty minutes treatment with conc. H_2SO_4 was suitable for *I. linnaei* and *M. alba* as against 10 minutes for *I. linifolia.* Seeds of *I. astragalina*, *I. glandulosa*, *M. Indica* and *M. denticulata* germinated when they were treated for 30 minutes. In *M. lupulina* 100% germination was achieved with 15 minutes treatment. Other species tolerated beyond 30 minutes of treatment although their germination potential declined appreciably (Tables-1 & 2).

On perusal of results, it seems that there is an extremely hard seed coat in *M. indica*, *I. linnaei* and *M. denticulata*. It is followed by *M. lupulina*, *M. alba*, *I. linifolia*, *I. astragalina* and *I. glandulosa*. Seedcoat becomes permeable to water and gases and inhibitors decline due to treatment with H_2SO_4. In *Mediago hispida*, *M. murcy* and *M. cilians* similar results have been observed by Yadav *et al.* (1979). Rama Krishnan and Khosala (1971), Agarwal and Vyas (1970), Sinha and Murty (1987) and Kumari (1993) also observed similar effects.

It is obvious that germination in *Melilotus*, *Medicago* and *Indigofera spp*. after scarification upto 50 -100% unequivocally proves that embryo is ripe and able to germinate on providing favourable conditions. It further confirms that dormancy is due to hard seed coat which prevents germination of such seeds in summer.

Microbial action is a natural scarification process (Wareing, 1963) and passage of seeds through digestive tract of birds or other animals or movement by water across sand or rock also result in natural scarification.

TABLE - 1 : Effect of scarification (conc. H_2SO_4) on germination percentage

Duration of treatment (Min)	Germination percentage			
	I. linanaei	*I. linifolia*	*I. astragalina*	*I. glandulosa*
05	26.0	40.0	20.0	25.0
10	40.0	88.0	50.0	50.0
15	72.0	80.0	85.0	85.5
20	88.0	50.0	90.6	87.76
25	44.0	08.0	95.0	90.0
30	30.0	00	100.0	100.0
35	25.0	00	60.0	60.0
40	20.0	00	45.0	40.0

TABLE - 2 : Effect of scarification (conc. H_2SO_4) on germination percentage

Duration of treatment (Min)	Germination percentage			
	M. alba	*M. indica*	*M. denticulata*	*M. lupulina*
05	37.6	50.6	20.0	50.0
10	70.3	60.3	25.0	60.0
15	75.0	86.6	30.0	100.0
20	100.0	90.6	30.6	100.0
25	90.0	85.5	40.4	100.0
30	86.6	70.0	50.0	100.0
35	60.0	50.0	45.0	100.0
40	40.0	30.0	10.0	80.0

In members of Caesalpiniaceae, alcohol treatment is effective. Chaudhary and Sinha (1989) worked out effect of thiourea, ascorbic acid and their interaction on seed germination in *Portulaca quadrifida*. Organic solvents like xylene, acetone and alcohol also remove dormancy in *Alysicarpus* spp.

Stratification

Low temperature induces anatomical and biochemical changes like increased gibberellin content and mobilization of food materials towards embryo. Peach, plum, cherry and apricot become free from dormancy by low temperature treatment (0 - 5°C) for a couple of weeks to a few months on moistened seed.

Pressure

It increases permeability and weakens the seedcoat. Generally high hydraulic pressure (about 2000 atm) at a temperature of 18 - 20°C for 5 - 20 minutes is applied on seeds. It is suitable for *Melilotus alba* and *Medicago sativa*.

Exposure to alternate temperatures

They change the permeability of seeds to gases and cause conversion of phytochrome and its recycling (Bhatia and Parasar, 1991).

After ripening storage

For this purpose, seeds are kept in gunny bag in earthen pot for required months. During storage, released CO_2 enhances temperature that allows embryo to develop. After required periods, i.e., 6 months to one year, seeds are taken out for germination. *Alysicarpus bupleurifolius* showed 30% removal of dormancy at 25°C during storage.

Hormonal treatments

In cereals the starch present in endosperm is digested by α-amylase, the synthesis of which is induced by GA_3. After digestion, it becomes available to embryo. Low temperature requirement can be substituted by GA_3. Srivastava (2005) reported enhanced germination in *Striga asiaticus* by ethylene.

The effect of GA_3 and cytokinin on germination percentage of unscarified and scarified seeds of *Indigofera* and *Melilotus* spp is shown in Table-3 and on scarified seeds of *Rauvolfia serpentina* in Table - 4.

The results show lower concentration of GA_3 and moderate concentration of cytokinin as suitable for removing seed dormancy.

Removal of germination inhibitors

Pandey and Goel (2003) observed that repeated washing of seeds with water and keeping them at lower temperature can promote seed germination in *Alysicarpus* spp.

TABLE - 3 : Effect of GA_3 and cytokinin on germination percentage

Concentration (ppm)		*I. astragalina*		*I. glanduloa*		*M. alba*		*M. indica*	
		Unsc.	SC	Unsc.	SC	Unsc.	SC	Unsc.	SC
	10	10	10	25	100	10	25	65	12
	25	25	17	17	100	5	22	50	16
GA_3	50	45	7	7	90	-	16	50	10
	75	10	5	5	80	-	10	20	10
	100	5	2	2	60	-	10	15	10
Cytokinin	10	8	90	10	100	10	25	10	93
	25	8	60	-	75	40	55	35	85
	50	5	50	-	65	30	20	5	65
	75	-	40	-	40	5	8	5	60
	100	-	10	-	50	5	5	5	50

Unsc = Unscarified, Sc = Scarified

TABLE - 4 : Effect of growth regulators on germination potential of *Rauvolfia serpentina*

Concentration (ppm)	Initiation period (days)	Rate of germination in scarified seeds per day (%)		Percentage of germination in Sc. per day in scarified seeds	
		Gibberellic Acid	Cytokinin	Gibberellic Acid	Cytokinin
Control	1	39.2	39.2	54.0	54.0
10	1	54.2	72.5	73.1	90.4
25	1	42.5	76.8	51.6	95.2
50	1	45.2	71.9	60.2	90.4
100	1	54.8	82.7	77.4	95.2

Seed dormancy - Spectrum of ecological adaptability

It is an ecological adaptation. It confers upon some species a selective advantage in distribution.

Wild legumes germinate after the rainy season is over and flower and fruit during February and March. During other months they remain dormant. Dormancy keeps the seeds free from injury during unfavourable conditions. During dry periods, the germination inhibitors present in seedcoat keep the seed inactive. When leached out due to rainfall, the seeds germinate. It protects the sp. during drought. Delayed germination of grains and seeds can help us in their storage and proper distribution both in time and space.

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