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# ECOLOGICAL STUDIES ON SEED GERMINATION OF *LEONOTIS NEPETIFOLIA* (L) AIT. F. IN RELATION TO ENVIRONMENTAL FACTORS WITH EMPHASIS ON FLUORIDE POLLUTED SOILS

Etude écologique de la germination de *Leonotis nepetifolia* (L.) Ait. f. en relation avec les conditions du milieu, en particulier sur des sols pollués par des fluorides

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*RESUME*

*L e o n o t i s n e p e t i f o l i a est une grande herbe de la famille des Lamiaceae. Sa distribution est pantropicale et elle est observée dans des paysages accidentés. Dans le district de Mirzapur dans l'Uttar Pradesh (Inde) la plante est caractéristique et dominante des sites pollués par des fluorides. Les graines fraîches présentent une dormance due à la présence d'inhibiteurs hydrosolubles dans l'exocarpe. La dormance prend naturellement fin après six mois de séjour en milieu sec, à des températures comprises entre 15 et 35° C (décembre à mai). La température constitue un facteur limitant important pour la distribution de L. n e p e t i f o l i a par son influence sur la germination. La graine ne germe pas à 15-20° C. Par contre, on observe près de 100 % de germination entre 26 et 30° C pour des sols dont l'humidité est comprise entre 40 et 60 % (conditions réalisées en saison des pluies, soit de juin à septembre) et avec des graines âgées de six mois. Ces observations fournissent des arguments qui permettent d'expliquer la restriction de la distribution de L. n e p e t i f o l i a aux régions tropicales. Les graines tolèrent de fortes teneurs de fluorides dans le sol; sous forme de fluorides de sodium, celles-ci peuvent atteindre 1500 µg par g de sol sec. Cette propriété en fait une espèce fort intéressante pour la recolonisation des zones polluées.*

*ABSTRACT*

*L e o n o t i s n e p e t i f o l i a, a tall herb of the Labiatae, presents a pantropical distribution, growing on uneven landscape. In Mirzapur district of Uttar Pradesh (India) the plant is characteristic and dominant in fluoride polluted areas. Ecological studies were conducted on seeds*

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*from this later provenance. Fresh seeds are dormant due to presence of water soluble inhibitor in seed coat. Dormancy naturally ends on dry storage for six months between 15-35° C (December to May). Temperature plays an important role in limiting the distribution of L. n e p e t i f o l i a by influencing its seed germination. Seeds do not germinate at 15-20° C. About 100 % seed germination is achieved between 28 to 32° C and 40 to 60 % soil moisture (rainy season : June-September) in six months old seeds. This provides an explanation regarding its restricted distribution to tropical regions. Seeds withstand high fluoride concentration up to 1500 µg (as sodium fluoride), which made this species very suitable for reclamation of polluted areas.*

## INTRODUCTION

The presence of any seed plant at a place or in a plant community is because of germination of seeds (CLAPHAM, 1956), except for a few multiplying vegetatively. WENT (1957) described that distribution, survival and continuation of generation depend upon seed germination.

Studies on germination of seeds in relation to environmental conditions and habitats of the plants are numerous (KAUL, 1973; THOMPSON & COX, 1978; OKUSANYA, 1980, etc.).

Pollution by gaseous hydrogen fluoride and flyash emitted by Hindustan Aluminium Company occurs at Renukoot, in Mirzapur district of Uttar Pradesh, India. *Leonotis nepetifolia* is characteristic and dominant in these fluoride polluted areas. It occurs also on wastelands.

*Leonotis nepetifolia* (L.) Ait. f. (Family Labiatae) is a tall, erect, 4-7 feet high annual weed. It is found growing throughout the hottest parts of India, Sri Lanka, South-east Asia, tropical America and Africa (DUTHIE, 1920). In India it is found growing wild on waste uneven ground where water does not accumulate for a longer period. In Africa it is common near dwellings and has been reported from *Kotschya* thickets on sandy high plateaux (MALAISSE, 1975). In Uttar Pradesh the species becomes very characteristic and dominant in fluoride polluted areas.

Present germination study was carried out with a view to explaining the ability of *L. nepetifolia* to establish in waste uneven grounds and in the fluoride polluted areas and confined to tropical regions of the world only.

## MATERIALS AND METHODS

Seeds of *L. nepetifolia* were collected in November, 1980 from its population growing at Renukoot on polluted fluoride soils. A portion of

the collected seeds were stored dry in envelopes in the cupboard and rest were used immediately for germination study.

The germination experiments were conducted by placing 100 seeds on wet filter papers in petridishes. Number of seeds germinated was noted everyday. Three replicates were made of each treatment. Germination was conducted under different conditions of light, soil moistures, at laboratory temperature (25° C) and at different temperatures viz, 10°, 20°, 30° and 40° C, soil depth (surface, 0.5 and 1 cm) and sodium fluoride (solutions with 10, 100, 200, 500, 1000, 1500 and 2000 p.p.m. NaF).

## RESULTS

### Morphology of seed

The seed is linear, oblong, tapering at one end and rounded at the other. Seed coat is provided with mucilage bursts out from epidermal cells as the seeds imbibe water. Moist seeds adhere each other and remain clumped together.

### Germination study

*Freshly collected seeds*.

It was observed that freshly collected seeds gave a very low germination percentage (40-45 %) even when sufficient moisture, alternating low and high temperature and different light conditions were provided. This indicated the presence of some sort of dormancy in some of the seeds. The period required to start the germination in non-dormant seeds ranged between 7-10 days.

*Treatment of seeds* (Mechanical scarification failed to induce germination)

Prior water, soaking is found to break dormancy of the seeds. Better germination in water soaked seeds indicated the presence of some chemical in the seed coat which inhibits the seed germination in untreated seeds.

*Storage effect*

To determine the effect of storage on germination stored seeds were kept for germination at monthly intervals. Seeds stored in dry conditions at room temperature varying between 15° to 35° C (December to May) showed storage effect. Stored seeds (six months old) showed 100 % germination (Tab. I). But 100 % germination was possible only at a temperature ranging between 28° to 32° C (Tab. III). Period required for initiation was reduced to 20 hrs. only instead of 10 days or so in fresh seeds (Tab. I).

| Age of seeds | Germination (%) | Time for initiation |
|---|---|---|
| Fresh seeds | 45 ± 1.0 | 10 days |
| 2 months | 50 ± 5.0 | 8 days |
| 3 months | 60 ± 7.2 | 5 days |
| 4 months | 75 ± 5.1 | 4 days |
| 6 months | 100 | 20 hours |

Tab. I : Effect of dry storage periods on seed germination of *Leonotis nepetifolia* at 30 ± 2° C.

| Variance due to | Degree of freedom | Sum of square | Mean sum of square | Ratio |
|---|---|---|---|---|
| Age of seed | 4 | 6224.4 | 1556.1 | |
| Error | 10 | 216.7 | 21.67 | 71.8* |
| Total | 14 | 6441.1 | - | |

Tab. II : Analysis of variance for the effect of age of seed on seed germination of *Leonotis nepetifolia*. * Significant at 1 % level.

| Temperatures (°C) | Germination (%) |
|---|---|
| 15 | 0 |
| 20 | 0 |
| 24 | 68 ± 5.29 |
| 28 | 100 |
| 32 | 100 |
| 36 | 80 ± 4.35 |
| 40 | 0 |

Tab. III : Effect of temperatures on seed germination of *Leonotis nepetifolia* (age of seeds : 6 months form the date of collection).

Three months old seeds showed 60 % germination. This result revealed that there are definite storage effects and a temperature regime of 28° to 32° C is an optimum temperature for germination of seeds in this species. Seeds did not germinate at 15°, 20° and 40° C (Tab. III).

One way analysis of variance (Tab. II) indicates that variations in percentage germination caused by different age of seeds are significant ($P<0.01$).

*Soil moistures effect*.

Weighed quantity of soil was taken in petridishes. A measured quantity of water was added to maintain the varied moisture levels viz, 10,

20, 40, 60 % (water holding capacity) and flooded. Water was daily added to compensate losses due to evaporation. Experiences were conducted at 30 ± 2° C. Results given in table IV reveals that moisture levels varying between 40-60 % are most suitable for the germination.

| Soil moisture % | Fresh seeds | 6 months old |
|---|---|---|
| 10 | NIL | NIL |
| 20 | 20 ± 1.7 | 40 ± 4.5 |
| 40 | 35 ± 6.0 | 90 ± 8.6 |
| 60 (W.H.C.) | 35 ± 3.4 | 80 ± 2.0 |
| Flooded | NIL | 10 ± 4.3 |

Tab. IV : Effect of different soil moistures on seed germination of *Leonotis nepetifolia* at 30 ± 2° C. W.H.C. : Water holding capacity.

*Soil depths effect*.

Seeds were sown at surface, 0.5 cm and 1 cm depths. Water was added on alternate day. Result (Tab. V) reveals that seeds sown at depper soil depths, did not germinate.

| Soil depths (cm) | Germination (%) |
|---|---|
| Surface | 82 ± 6.5 |
| 0.5 | 40 ± 3.0 |
| 1.0 | NIL |

Tab. V : Effect of soil depths on germination of seeds of *Leonotis nepetifolia* at 30 ± 2° C (age of seeds : 6 months).

*Effect of sodium fluoride (NaF)*.

Germination occured only in up to 1500 p.p.m. solutions although the percentage germination followed decreasing trend after 500 p.p.m. (Tab. VI).

| Concentrations (p.p.m.) | Germination (%) |
|---|---|
| 10 | 100 |
| 100 | 100 |
| 200 | 100 |
| 500 | 92 ± 2.00 |
| 1000 | 80 ± 6.2 |
| 1500 | 50 ± 3.4 |
| 2000 | NIL |

Tab. VI : Effect of NaF on germination of seeds of *Leonotis nepetifolia* at 30 ± 2° C.

Statistically it was found that germination percentage was negatively correlated ($r = -0.92$) with the concentrations of NaF and the value of correlation coefficient was significant at 0.01 level. One way analysis of variance (Tab. VII) indicates that variations and percentage germination caused by different concentrations of NaF are significant ($P < 0.01$).

| Variance due to | Degree of freedom | Sum of square | Mean sum of square | Ratio |
|---|---|---|---|---|
| Concentrations | 5 | 5850 | 1170 | |
| Error | 12 | 110 | 9.1 | 128.5* |
| Total | 17 | 8960 | - | |

Tab. VII : Analysis of variance for the effect of different concentrations of NaF on seed germination of *Leonotis nepetifolia*.
* Significant at 1 % level.

## DISCUSSION

The results reveal that seed germination of *L. nepetifolia* is governed by several factors viz, temperature, soil moisture and storage period. Improved percentage germination in presoaked seeds indicate the presence of some water soluble chemical in the seed coat of this species which inhibits the germination of freshly collected seeds but on dry storage for about six months at a temperature range of 15°-35° C the effect of inhibitory substance disappears resulting into 100 % germination. Naturally occuring chemicals in the seeds are eliminated by time, temperature changes, leaching, decay of surrounding fruit tissue, light and by other ways in natural conditions (TOOLE *et al.*, 1956). In *L. nepetifolia* germination inhibitor is eliminated by the storage period. MAYER & POLJAKOFF-MAYBER (1963) have also described that substances inhibiting germination may disappear on dry storage.

Since seeds are a mean of propogation of the species, hence their germination should occur at a time which will favour survival of the seedlings under prevailing environmental conditions, i.e., 28° to 32° C temperature and 40 to 60 % soil moisture required for the germination of the seeds of *L. nepetifolia* coincide with the conditions of the environment prevailing at its habitat in tropical countries (Tab. VIII) when the seeds germinate in nature during June and July for the Northern hemisphere. But this condition does not prevail at the time of seed dispersal in the month of November / December when the temperature is found to

range between 10 to 25° C and soil moisture range is 6 to 15 % in tropical India.

| Region<br>Town<br>Country | Tropical | | Mediterranean | Temperate |
|---|---|---|---|---|
| | Varanasi*<br>India | Lagos°<br>Nigeria | Milan°<br>Italy | Cambridge°<br>England |
| Mean annual temperature (C) | 25.9 | 31 | 16 | 11 |
| Mean January temperature (C) | 16.2 | 25 | 5 | 0 |
| Mean July temperature (C) | 29.9 | 30 | 26 | 20 |
| Precipitation (mm) | 1100 | 1850 | 1200 | 750 |
| Growing period (day) | 365 | 365 | 300 | 348 |

Tab. VIII : Comparative meteorological date for certain tropical, mediterranean and temperate regions of the world. * Data from Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, India. ° Data from OKUSANYA (1980).

This adverse period is overcome by seed coat dormancy caused by the presence of germination inhibitor. Seeds gradually become non-dormant during dry storage.

The need of 40 to 60 % soil moisture for seed germination of this species explains the cause of the emergence of tis seedlings after rains, when adequate moisture along with suitable temperature is available for germination. Its presence on uneven ground and slope is based on the fact that its seeds do not germinate in flooded land.

The species is confined to the tropical parts of the world. This is also confirmed with the specific requirements of 28-32° C temperatures and 40-60 % soil moisture for its germination. Such conditions only prevail in tropical countries (Tab. VIII). The prevailing temperatures during spring and early summer in temperate regions range between 15-20° C and at this temperature range the seeds do not germinate.

Seeds need special conditions for their germination for which they have to remain dormant for about seven months.

Outer coating of the seed becomes mucilaginous on coming in contact with water which helps in the water flox to the seed by extending the pathway. Similar phenomenon of presence of mucilage in *Lepidium sativum*, *Camelina sativum*, *Linum usitatissimum*, *Plantago major* and *Sinapsis alba* has been described by HARPER & BENTON (1966).

The fact that the seeds of *L. nepetifolia* could germinate in the solutions of NaF up to the concentrations of 1500 p.p.m. explains the cause of its successful establishment in the aeras polluted by hydrogen fluoride.

Thus it can be concluted that specific temperature and soil moisture requirements for the germination of seeds of *L. nepetifolia* restrict the species to only on uneven lands in tropical regions. Its high fluoride tolerance helps it to grow in fluoride polluted areas and made it a useful plant for land reclamation. Further researches are needed in order to establish its possibilities on other anthropic environmental conditions.

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