6. SUMMARY

The present study entitled "Studies on seed dormancy constraints and methods of their overcoming in some medicinal plants" was undertaken to work on seed dormancy of medicinal plants. The research work was carried out in the Research Laboratory of the Department of Botany, Meerut College, Meerut (U.P.) during the session 2003-2004 and 2004-2005 on the plants, Isabgol (Plantago ovata), Ashwagandha (Withania somnifera), Khangri (Abutilon indicum), Senna (Cassia angustifolia), Acnla (Emblica officinalis), Bael (Aegle marmelos), Reechha (Raphia triflora) and Muleth (Glycyrrhiza glabra). The seeds for the study were procured from NBPG, Pusa Campus, New Delhi-12 and other reliable sources. The understanding of causes and cure of the seed dormancy of medicinal plants is the need of the day with increasing interest of farmers for cultivation/propagation of these crops being more remunerative and the plant breeders engaged in research on various aspects of medicinal plants. The present investigation was undertaken with the following objectives:

1. To work out germination and viability tests for the listed plant species.
2. To study the morphological and other characteristics of the seed for identifying the causes for seed dormancy.
3. To work out the effect of various physical and chemical treatments on germination.
4. To study the effect of temperature and light treatments on germination
5. To find out the Synergistic effect of different treatments
6. To develop a suitable protocol for breaking seed dormancy based on the above findings

In order to achieve the desired objectives of the study the following parameters were studied:

1. Seed coat structure and morphological characters
2. Imbibition rate of seeds
3. Seed viability test (tetrazolium chloride test)
4. Electrical conductivity of seed leachates
5. Seed germination and seedling vigour

The following different treatments were employed towards overcoming the dormancy of seeds:

1. Seed scarification
   i. Mechanical scarification
   ii. Acid scarification (1, 5 and 10N, 25, 50 and 100%)
   iii. Hot water treatments
2. Stratification
   Pre-chilling seed treatments
3. Chemical treatments
   i. GA₃ (100, 200 and 300 ppm)
   ii. KNO₃ (0.1, 0.5 and 1.0%)
   iii. Thiourea (0.1, 0.5 and 1.0%)

The aforesaid treatment were applied for different durations as pre-sowing seed treatments. The combinations of treatments were also applied in some seeds.
The salient findings of the present study is being summarized as follows:

6.1 SEED CHARACTERISTICS

1. The seeds of the plants under study were categorized into three groups on the basis of their seed weight and size.

- **A Small seed**
  - *Pentago ovata* (Forsk.)
  - *Ambelone sommerfuga* (Linn.)
  - *Abutilon velutinum* (Linn.)

- **B Medium seed**
  - *Cassia angustifolia* (Var.)
  - *Embelia officinalis* (Gaertn.)
  - *Anogeissus latifolius* (Linn.)

- **C Bulb seed**
  - *Sapindus tiliifolius* (Linn.)
  - *Glycyrrhiza glabra* (Linn.)

2. On the basis of nature of seed coat the seeds of medicinal plants under study were categorized into three groups.

- **A Normal coat seed**
  - *Pentago ovata* (Forsk.)
  - *Ambelone sommerfuga* (Linn.)
  - *Anogeissus latifolius* (Linn.)

- **B Hard coat seed**
  - *Abutilon velutinum* (Linn.)
  - *Cassia angustifolia* (Var.)
  - *Embelia officinalis* (Gaertn.)

- **C Very thin coat seed**
  - *Sapindus tiliifolius* (Linn.)
  - *Glycyrrhiza glabra* (Linn.)

6.2 SEED VIABILITY, ELECTRICAL CONDUCTANCE AND DORMANCY STATUS

The seed viability of the plants under study were found out with Triphenyl tetrazolium chloride (TZ) quick viability test for the seeds of
collected in 2003-2004 and 2004-2005 year. The seeds collected over two years showed high level of viability percentage (90-100%).

The electrical conductance of the seed extractates from the seeds (1g) soaked in water for 4 hr was low (0.045-0.405 µmho cm) again indicating the intactness of cellular membranes and viability of seeds.

The seeds of the plants under study when were provided favourable conditions, otherwise suitable for germination of a normal seed recorded 0-10 per cent of germination. Thus seeds of all the plants were exhibiting high level of dormancy.

6.3 IMBIBITION RATE OF SEEDS

The seeds (1g) of different medicinal plants under study showed diversity in their water uptake behaviour.

i. The highest rate of water imbibition was shown by the seeds of *Plantago ovata* followed by *Abutilon indicum* and *Cassia angustifolia*.

ii. The water imbibition rate was moderate in *Emblica officinalis*, *Aegle marmelos* and *Glycyrrhiza glabra*.

iii. The lowest rate of water imbibition (0.041-0.052 g/g seed/day) was recorded by the seeds of *Sapindus tinctorius* which has a very hard seed coat indicating impermeability to water.

iv. The high rate of water imbibition (1.537-1.651 g/g seed/day) by *Plantago ovata* on one day of seed soaking may be attributed to the presence of mucilaginous matrix on the seed coat.

v. The imbibition rate of the seeds of *Withania somnifera* is quite different from the other seeds under study. It showed very low imbibition rate during two days of soaking and there after steady increase up to 4 days of
soaking. It may be due to the fact that (a) the nature of seed coat initially impedes the water uptake (b) the seed has less amount of matrix of reserve food substances.

vi. The imbibition rate of the seeds improved after the scarification using mechanical acid and hot water in the seeds and especially in the case of *Strophanthus inofficinalis*, it enhanced more than 10 folds.

6.4 EFFECT OF DIFFERENT PRE-SOWING SEED TREATMENTS ON GERMINATION PATTERN AND SEED VIGOUR INDEX IN MEDICINAL PLANTS

6.4.1 *Plantago ovata*

The seeds of *Plantago ovata* were given hot water treatments, pre-chilling chemical GA₃ (100, 200 and 300 ppm), KNO₃ (0.1, 0.5 and 1.0%) and thiram (0.1, 0.5 and 1.0%) and chilling + chemicals for different durations (24 hr) to overcome the dormancy.

i. The hot water (70°C) treatment for 10, 20 and 30 minutes was not much effective rather longer exposure to hot water damaged the seed germinability as shown by poor or nil germination.

ii. The germination percentage (90-100%), vigour index (438-540) and speed of germination (22.6-24.7) were recorded when seeds were given pre-chilling treatments (72 and 48 hr). The pre-chilling treatment of 24 hr was not much effective.

iv. The pre-sowing soaking of seeds in GA₃ (200 ppm) for 24 hr duration resulted into higher germination percentage (70%), vigour index (434) and speed of germination (14.5) as compared to other GA₃ (100 and 300 ppm) and other chemical treatments (KNO₃ and thiram).
The pre-chilling (24 hr), followed by the soaking (24 hr) of seeds in GA$_3$ (200 ppm), KNO$_3$ (0.5%), and thiourea (0.5%) had synergistic effects and improved the germination percentage (80-100%) and speed of germination (14-19) significantly over either one alone.

The requirement of prolonged 48 and 72 hr pre-chilling treatments was substituted with the application of 0.5% KNO$_3$ (24 hr soaking) following 24 hr pre-chilling seed treatments as the germination percentage under both treatments were at par.

Thus, the pre-chilling treatment of 72 hr is most effective treatment followed by 48 hr chilling and pre-chilling (24 hr) + 0.5% KNO$_3$ (24 hr) soaking to overcome the dormancy of Plantago ovata seeds.

### 6.4.2 Withania somnifera

The seeds of Withania somnifera were given hot water and chemical treatment i.e., GA$_3$ (100, 200 and 300 ppm), KNO$_3$ (0.1, 0.5 and 1.0%), and thiourea (0.1, 0.5 and 1.0%) for different durations to overcome the dormancy.

- The exposure of seeds to hot water for 10 minutes recorded 50 percent germination whereas the longer exposure (20-30 minutes) resulted in 0 to 5 percent germination.

- The maximum germination percentage (95.96%), vigour index (480-523), and speed of germination (13.6-14.3) were recorded with 0.5 percent KNO$_3$ soaked seeds followed by 300 ppm GA$_3$ soaked seeds for a duration of 24 hr.
The application of thoura treatment to the seeds was not much effective in terms of germination percentage and vigour index as compared to KNO₃ and GA₃ treatments.

6.4.3 Abutilon indicum

The seeds of Abutilon indicum were given mechanical and acid scarification, hot water and chemical viz. GA₃ (100, 200 and 300 ppm), KNO₃ (0.1, 0.5, 1.0%) and thoura (0.1, 0.5 and 1.0%) treatments.

The exposure of seeds to hot water for 20 minutes resulted into maximum germination percentage (80.82%), vigour index (303.344) and speed of germination (13.01-16.35) followed by 10 minutes exposure to hot water.

The seeds soaked in GA₃, KNO₃ and thoura solution for 24 hr duration was not found too much effective to overcome the dormancy.

The acid (5N H₂SO₄) scarification was effective in enhancing the germination percentage (40.42%) and speed of germination (7.8-9.5) as compared to germination percentage (15-18) and speed of germination (2.2-2.5) under mechanical scarification.

6.4.4 Cassia angustifolia

The seeds of Cassia angustifolia were given hot water, mechanical, and scarification and chemical treatments, 12 and 24 hr soaking durations and the combination of mechanical scarification with chemical treatments.

Mechanical scarification treatment in the seeds exhibited two to three fold higher germination percentage (75.83), vigour index (780-920) and
speed of germination (23.5-24.5) as compared to acid scarification and hot water treatment.

i. The seeds soaked for 24 hr in 1.2% KNO₃ solution exhibited higher germination percentage (49) and speed of germination (24) followed by 600 ppm GA, soaked (24 hr, seeds)

v. The synergistic effect of mechanical scarification plus chemical treatments (600 ppm GA, 1.2% KNO₃ and 5.1% thiorurate for 24 hr soaking) was observed in terms of enhanced germination percentage (90.100)

v. The seeds given mechanical scarification plus 300 ppm GA (24 hr soaking) recorded maximum vigour index (1810-1700) and speed of germination (22.5-23.4) while thiorurate (6.0% application) enhanced the vigour index (1600-1130) and speed of germination (28.0-26.2)

6.4.5 *Emblica officinalis*

i. The seeds of *Emblica officinalis* were given mechanical scarification, hot water treatment and mechanical scarification + chemical (GA, KNO₃ and thiorurate) treatments.

i. The exposure of seeds to hot water for 10 minutes resulted in higher germination percentage (85-85) compared to 20 and 30 minutes hot water exposure and mechanical scarification

ii. The synergistic effects of mechanical scarification for peas, plus 0.5 per cent KNO₃ (24 hr soaking) treatments were recorded in terms of highest germination percentage (45-100%), vigour index (722-870) and speed of germination (16.8-27.8) followed by 200 ppm GA treatments.
The application of different mechanical and chemical scarification treatments on seedling vigour and speed of germination

6.4.6 *Aegle marmelos*

The results of *Aegle marmelos* were given hot water, acid scarification and chemical treatments viz. GA$_3$ 100, 300 and 500 ppm, KNO$_3$ 0.1, 0.5 and 1.0% and Indurex 0.1, 0.3 and 0.6%.

A 30 minute exposure of seeds to hot water and 10 minutes exposure of seeds to H$_2$SO$_4$ (5N) and exibited a far germination percentage while vigour index and speed of germination were higher in hot water treatment.

The maximum percentage of germination (73-80, 75-78%) vigour index (121-124, 125-140) and speed of germination (8.4-11.5, 7.6-10.7) were observed in the seeds soaked in 200 ppm GA$_3$, and 0.5 per cent KNO$_3$ solution for 24 hr duration respectively.

6.4.7 *Sapindus trifoliatus*

The seeds of *Sapindus trifoliatus* were given mechanical (chipping), hot water, acid scarification and mechanical scarification + chemical (GA$_3$, KNO$_3$) and indurex treatments.

The hot water treatments of seeds was not found effective to overcome dormancy as only 10-12% germination was observed.

The seeds scarified with 25% conc. H$_2$SO$_4$ acid treatments recorded higher germination percentage (70-75%) among other scarification treatments.

The synergistic effects of mechanical scarification (chipping) + 0.5 per cent KNO$_3$ 24 hr soaking treatments were observed in terms of
maximum germination percentage (85-95%), vigour index (1463-1558) and speed of germination (20) followed by the mechanical scarification (chipping) + 200 ppm GA_3 + 24 hr soaking.

6.4.3 Glycyrrhiza glabra

i. The seeds (roots) of Glycyrrhiza glabra were given mechanical hot water and acid scarification and mechanical scarification plus chemical (GA_3, KNO_3, and Imicrole) treatments

ii. The seeds (roots) exposed to hot water (70°C) for 60 minutes recorded 25 to 30 per cent germination only.

iii. The maximum germination percentage (75-80%), vigour index (240-304) and speed of germination (16.7-17.3) were observed in the seeds scarified with 100% H_2SO_4 for 5 minutes treatment.

iv. The mechanically scarified seeds following 24 hr soaking in 300 ppm GA_3 and 0.5% KNO_3 solution exhibited the germination percentage (62-65%: 42-49%), respectively against mechanical scarification alone i.e. 38 to 40 per cent germination.