

## Ecophysiology of Seed Germination in *Pinus halepensis* and *P. brutia*: the Role of Light

Costas A. Thanos\* and Antonis Skordilis

### ABSTRACT

*Pinus halepensis* Mill. (Aleppo pine) and *P. brutia* Ten. (East Mediterranean pine) are common, low-altitude pines, growing in extended areas around the Mediterranean basin. It is already known that continuous red (R) light or diurnal white light promote the germination rate and in certain cases the maximum germination percentage. Continuous or intermittent far-red (FR) light inhibits germination and induces a photodormancy. The present study involves seeds from several provenances of both species and comprises a detailed investigation of the ecophysiological responses of germination towards light; it is also an attempt to evaluate their field germination capability and characteristics in forest gaps and beneath vegetation cover. Seeds were imbibed under temperature and light conditions simulating, on a monthly basis, those met naturally throughout the year in a typical Mediterranean site. Seeds kept continuously in darkness showed a slower rate of germination and in several cases a decreased germinability. The effects of white light gap duration and timing during a broadband FR day (simulating light conditions under a dense canopy) on the germination of *P. halepensis* and *P. brutia* seeds were particularly marked. Although FR light was fully inhibitory for both species, a WL break as short as one hour was shown to enhance dramatically the final germination. A 2-hr WL 'gap' (irrespective of its timing during the FR day) fully restored germinability in *P. halepensis* while 4 hours of WL were required in *P. brutia*. In addition to the previous conclusion that even a considerably small amount of WL is sufficient to counteract the inhibitory FR action, seed germinability was found to be suppressed only at 'very dense canopy' conditions. When the daily-applied WL irradiation was filtered through different broadband filters, establishing in imbibing seeds different phi values (corresponding to different levels of active phytochrome,  $P_{fr}$ , at photoequilibrium), final germinability of *P. halepensis* seeds was found to be fully controlled by the phytochrome status (germination range 0–100%). However, germination was maximal when the estimated phi values exceeded 0.2 (corresponding to an intermediate canopy shading) while it declined sharply at lower phi values and was totally inhibited at values below 0.05.

Costas A. Thanos and Antonis Skordilis, Department of Botany, University of Athens, Athens 15784, Greece. \*Corresponding author. Received 4 June 2003.

## Preliminary Studies on Seed Longevity of *Pongamia pinnata*

Maitreyee Kundu\*

### ABSTRACT

The seeds of *Pongamia pinnata* were stored at four moisture contents of 4.5 to 11.8% and four temperatures of  $-20$  to  $15$  °C. Seeds were sampled at intervals up to three years for assessment of germination capacity and viability equations were used to express the relationship between storage conditions and viability of seeds. Drying the seeds to 4.5% moisture content did not affect the germination and the seeds can best be stored at 4.5% moisture content and  $-20$  °C, therefore supporting the orthodox nature of the seeds of this species. The upper moisture limit is very low (12%). The relation between upper limit and oil content of seeds has been discussed.

Maitreyee Kundu, Rain Forest Research Institute, P.O. Box 136, Jorhat 785001 Assam, India rainfor@sancharnet.in \*Corresponding author. Received 4 June 2003.

## Germination of *Citrus grandis* L. Seeds and Seed Greening Disease Testing by PCR (Polymerase Reaction Chain)

Le Quang Hung

### ABSTRACT

Seeds of *Citrus grandis* L. “Buoi Duong” and *Citrus grandis* L. “Buoi Thanh Tra” germinated at  $30/20$  °C (16/8h) reached high germinations of 97% at 43.7% moisture content (mc) and 93% at 39.1% mc, respectively. Germination percentages were reduced with desiccation to low moisture content (3.3%) to 21% for “Buoi Duong” and 19.4% for “Buoi Thanh Tra”. The results of testing showed that these two seed lots were intermediate in seed storage behavior. Seed of these lots showed negative with greening disease by testing with PCR (Polymerase Reaction Chain) and these seed lots were used as stock for grafting.

Note: In the GRIN, *Citrus grandis* L. is a synonym for *Citris maxima* (Burm.) Merr.

Le Quang Hung, Nong Lam University, Ho Chi Minh City, Vietnam. Received: 4 June 2003.

## **Histological Study on Seed Ageing in Sunflower (*Helianthus annuus* L.) Hybrid KBSH-1 and Its Parental Line**

P. R. Renganayaki and V. Krishnasamy

### **ABSTRACT**

Biochemical and physiological properties of seeds play a major role in determining seed quality. In the case of hybrid seed production involving CGMS system, the genetic makeup of each line is different. The hybrid inherits the genetic makeup in varying degrees, which decides the hybrid seed quality. Morphological and anatomical characteristics of seed and seed coat is of great importance in maintaining the viability during ageing. The pattern of senescence varies with parental lines. A study on histology was conducted to determine the role of seed coat on maintaining the viability during ageing. Microtomed sections of seed coat exhibited a greater number of hard sclerenchymatous cells in the epidermal layer of females and hybrids than were observed in the maintainer and restorer lines. Such hard cells would offer resistance to leaching of internal solutes, thereby favouring seed storability. Since the seed coat of the hybrid is developed from the maternal integument, the structure of the female and the hybrid remained similar.

P.R. Renganayaki\* and V. Krishnasamy, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003. \*Corresponding author. Received 4 June 2003.

## **Standardization of Planting Ratio for Hybrid Seed Production in Sunflower (*Helianthus annuus*, L.) Hybrid KBSH-1**

P. R. Renganayaki\* and V. Krishnasamy

### **ABSTRACT**

A study was undertaken to standardize suitable planting ratio for successful hybrid seed production in sunflower (*Helianthus annuus*, L.) hybrid KBSH-1. This is the most popular hybrid released from Bangalore. The hybrid seed production system in sunflower includes, pollination of CGMS line (A) with maintainer line (B) on one hand to produce 'A' line seed and with restorer line R on the other hand to produce hybrid. In majority of the cases, the pollination is very much inadequate resulting in poor seed set. To have effective pollen supply from male to female parent, the parental lines are to be planted in a definite row ratio. It varies depending upon the pollen production, pollen viability and pollinating agent. The study revealed that among the female rows, the first three rows nearer to male parent were on par in seed set and, thereafter, a gradual decline in seed set was noticed up to 8th

row and from 9th row onwards a moderate increase in seed set was observed up to 12th row. The higher seed set in first and last three female rows from male row could be due to the availability of sufficient pollen and closeness of the pollinator to the seed parent. Seeds obtained from first three rows of female parent nearer to male exhibited higher 100-seed weight and germination percent compared to seeds from the female plants farther away from the male row. Since seed set of three rows on either side of the pollen parent were on par, a row ratio of 6:1 (female:male) could be recommended for sunflower hybrid KBSH-1 seed production. The staggered sown crop registered 20 percent higher seed yield than the crop in which male and female parents were sown simultaneously.

P. R. Renganayaki\* and V. Krishnasamy, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 3. \*Corresponding author. Received 4 June 2003.

## **Reforestation on Airplane Sowing Tree Seeds Treated with Electrostatic Field in Northern Mountains of China**

Zhibin Gui\*, Shengdi Wu, Limin Qiao

### **ABSTRACT**

Sustainable forest regeneration depends on fast establishment of young tree seedlings by sowing tree seeds in the mountains, or in nurseries for direct seeding. The establishment success of a young tree seedling from a tree seed in the nursery, or in the mountains, depends on the quality of the seed lot, such as, the developmental degree of the embryo, the viability, degree of dormancy of seeds, as well as selecting pretreatment method, such as Electrostatic Field, Microwave treatment, and so on. In order to reforest in the mountains, some pine seeds as well as other seeds were treated indirectly by means of a Direct Current Filed (Electrostatic Field). The germination tests in the room, sowing tests by hand in the mountains, and reforestation tests by aerially sowing seeds were made. The experimental results showed that the success to the forest not only depends on good quality tree seeds, but also an effective treatment method of the tree seeds selected. For the electrostatic field treatment, the time of improving germination was 1–2 days. The temperature difference of the seeds before treatment and after treatment was little. The percentage of improving germination was 10–57% more than the control group, respectively. The maximum percentage of increasing young seedlings in the mountains of the treatment group was one time more in the northern-west mountains of Shaanxi of China.

Zhibin Gui \*, Xidian University ,Xian 710071,China (zhbgui@mail.xidian.edu.cn); Shengdi Wu, Airplane sowing Department of Shaanxi, 710082, China; Limin Qiao, Xidian University, Xian 710071, China. \*Corresponding author. Received 4 June 2003.

## Genotype Influences on Acorn Nutrient Concentrations (*Quercus robur* L.)

N. Nikolic, S. Orlovic, and B. Krstic

### ABSTRACT

The objective of this study was to determine macronutrient (N, P, K, Ca, Mg and Na) concentrations in different parts of English oak's acorn to estimate genotype variability of these traits. Acorns were collected during the 1998 harvest from seventeen *Quercus robur* L. genotypes. Trees originate from vegetative seed plantation Banov Brod, belonging to a Forest Estate Sremska Mitrovica (Srem, Vojvodina, Serbia). The investigation of nutritional status of acorns revealed the significant differences among the studied genotypes. Considering all genotypes, the general sequence of the nutrient amounts for cotyledon tissue was as follows: N>K>Ca>P>Mg>Na. Concentrations of Ca and Mg were higher for pericarp and seed coat than for cotyledon tissue. Pericarp and seed coat nutrient concentrations showed lower variability compared with cotyledon's, with the exception of potassium concentration.

N. Nikolic, S. Orlovic, and B. Krstic, Faculty of Natural Sciences, Department of Biology and Ecology, Trg Dositeja bradovica 2, 21000 Novi Sad. \*Corresponding author. Received 4 June 2003.

## Storage of Scarified *Acacia cyanophylla* Seeds

Beti Piotto\*, Elisabetta Falleri, Raffaello Giannini, Giuseppe Tranne

### ABSTRACT

Untreated and mechanically scarified seeds of *Acacia cyanophylla* were stored for 0, 6, or 12 months at +3 °C or -3 °C, in sealed containers or in vacuum packing. Scarification was performed in an *ad hoc* modified Forsberg scarifier operated electrically. Twenty-four different treatments, studied through a multifactor design, were experienced. Considering the effect of single factors on germination, mechanically scarified seeds gave the most rapid and complete germination compared to untreated ones. No influence was recorded for storage temperature and kind of container. Highly significant differences for storage periods were found: seeds stored for 12 months attained higher germination percentages than seeds stored for 0 or 6 months. Scarified seeds stored much better than untreated ones in all storage durations. As no loss in germination was observed, it seems reasonable to assume that storage for at least 12 months is highly safe for scarified seeds. These results, having practical applications for commercial seedsmen or nurserymen, express a good utilisation of simple, modern seed technology since seed can be scarified properly and then easily stored until delivery.

Note: In the GRIN, *Acacia cyanophylla* Lindl is a synonym for *Acacia saligna* (Labilla) H.L.Wendl.

Beti Piotto\*, Agency for the Protection of the Environment and for Technical Services, Via V. Brancati

48, 00144 Rome. piotto@apat.it; Elisabetta Falleri, Department of Science and Technologies of the Forest Environment (DISTAF), University of Florence, Via San Bonaventura 13, 50145 Florence; Raffaello Giannini, Department of Science and Technologies of the Forest Environment (DISTAF), University of Florence, Via San Bonaventura 13, 50145 Florence. efaller@tin.it; Giuseppe Tranne, Sustainable Development Service, Ministry of the Environment and Territorial Protection, Via Cristoforo Colombo 44, 00147 Rome. \*Corresponding author. Received 4 June 2003.

## Effect Size and Density of Seeds on Seed Quality in *Terminalia chebula* and *Terminalia bellirica*

M. Sivaprakash, G. Dharmaraj, P. R. Renganayaki and M. Jayaprakasam

### ABSTRACT

A number of studies in tree species showed that grading is an integral part of post harvest operations to enhance the planting value of seed lots. Grading to remove the empty, immature, broken and insect damaged seeds is done mainly to improve the physical and physiological quality of the seed lot. In order to improve the seed quality, these studies were conducted during 2000–2002. The results of the size grading (visual) of seeds indicated that medium and bigger size seeds performed better than the smaller size seeds in terms of early germination (28, 28%), speed of germination (0.634, 0.631), germination percentage (49, 52%), and seedling height and vigor (14.69, 16.16) in *T. chebula* and *T. bellirica* respectively. Density grading of *Terminalias* using water, 2% NaCl and 3% NaCl showed advantage rather than size grading. In all the three solutions sinkers performed better with early germination (27, 19.5%), speed of germination (0.682, 1.375), germination percentage (50.5, 68%), seedling height and vigor index (13.88, 53.137) in *T. chebula* and *T. bellirica*, respectively. From the study it can be concluded that, by density grading using floatation techniques, ill filled, air spaced and empty seeds of *T. chebula* and *T. bellirica* can be removed.

M. Sivaprakash\*, G. Dharmaraj, P. R. Renganayaki and M. Jayaprakasam, Forest College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam – 641 301, Tamilnadu. \*Corresponding author. Received 4 June 2003.

## Standardization of Seed Extraction Methods in *Terminalia chebula* Retz. (Kadukkai) and *Terminalia bellirica* Roxb. (Thandrikai)

M. Sivaprakash, G. Dharmaraj, P. R. Renganayaki and M. Jayaprakasam

### ABSTRACT

*Terminalia chebula* Retz. and *T. bellirica* Roxb., belong to the family Combrretaceae. The family is of great importance in forestry. The genus *Terminalia*

is the source of a number of timbers of commercial importance. The myrobalans, which are the dried fruits of *T. chebula* and *T. bellirica* are the most important among the different valuable products. The seed extraction is a problem. Hence, a study was conducted to standardize the best seed extraction method. The better seed management practices started from extraction of the seeds. Faulty procedures if applied may reduce the germinability, physical damage and reduce storability. The purpose of extraction is to promote germination and to offer a better seed handling practice. A series of treatments (total 26) were tried to standardize a better seed extraction method for both species. Among the different methods tried, mechanical extraction was found to be best for both the species. In *T. chebula* and *T. bellirica* mechanically extracted seeds (by seed hammering) completed germination very early (43 and 36.5 days respectively) when compare to other treatments. In *T. chebula* and *T. bellirica*, the highest germination percentage and vigor index were recorded in mechanically extracted seeds (48 and 68%; 10.665 and 46.774 respectively). Thus, mechanical extraction is the best method of seed extraction for both species. Mechanical extraction disrupts the barrier for the uptake of water by the seed and permits the radical to emerge by weakening seed coat structures.

M. Sivaprakash\*, G. Dharmaraj, P. R. Renganayaki and M. Jayaprakasam, Forest College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam – 641 301, Tamilnadu. \*Corresponding author. Received 4 June 2003.

## Seed Storage Studies in *Terminalia chebula* and *Terminalia bellirica*

M. Sivaprakash, G. Dharmaraj, P. R. Renganayaki and M. Jayaprakasam

### ABSTRACT

Because of the diverse biological activities taking place in seed during storage, seed deteriorative process in terms of physical, physiological and biochemical attributes results in complete loss of viability, i.e., death. To study the viability status of the *Terminalia* seeds, an experiment was conducted during 2000–2002. The freshly fallen fruits of *T. chebula* and *T. bellirica* were collected from the ground and dried to a moisture content of 12% and packed in fresh gunny bag and stored under ambient conditions. To avoid pest and disease damage during storage the seeds were treated with Thiram and Bavistin at 3 g/kg of seed. The results revealed that the *Terminalia* species can be stored with pre-treatment of Thiram and Bavistin for a period of one year with higher germination, seedling length and vigor index than fresh seeds. When the results were compared to fresh seeds, the older seeds performed well in terms of early and better germination percentage, indicating the release of hard seededness, over the period of storage. No significant variation was observed for 100 fruit weight and moisture content irrespective of

treatments and period of storage. Maintenance of viability during storage may also be due to hard seededness, which did not permit the external moisture to enter into the seed, to maintain the optimum moisture content throughout the storage period.

M. Sivaprakash\*, G. Dharmaraj, P. R. Renganayaki and M. Jayaprakasam, Forest College and Research Institute, Tamil Nadu Agricultural University, Mettupalayam – 641 301, Tamilnadu. \*Corresponding author. Received 4 June 2003.

## Seed Handling Practices of Janum (*Syzygium cuminii* skeels)

I. Vijayaraghavan, P. R. Renganayaki, G. Dharmaraj

### ABSTRACT

Agroforestry, social forestry, silvipasture, hortisilvipasture, urban and recreation forestry are the few systems of a forestation program for greening of wastelands. Jamun is an evergreen, moist, deciduous tree used as fuel and timber, and its seeds have highly medicinal properties. They are propagated mostly through seeds. Since it is a recalcitrant seed, an investigation was made to study the storage behavior of freshly collected jamun seeds of different fruit size by storing in different media at different moisture conditions, viz, 25, 30, and 35%. Of these, seeds stored in sand medium at 35% performed better for up to 4 months of storage. Also, the big sized seeds gave four vigorous seedlings (polyembryony) when compared to all other seed size and moisture content up to 4 months of storage.

I. Vijayaraghavan, P. R. Renganayaki, G. Dharmaraj, Forest College & Research Institute, Tamil Nadu Agricultural University, Mettupalayam. Received 4 June 2003.

## Relationship Between Cone Weight and Seed Traits as Revealed by Several Years on *Cedrus atlantica* Individuals at Tala-guilef (Djurdjura, Algeria)

F. Krouchi and A. Derridj

### ABSTRACT

Cone weight, total number of seeds per cone, amount of filled seeds, weight of filled seeds and their *in vitro* germination were examined during several years on identified individuals of *Cedrus atlantica* in a natural stand located at Tala-guilef Djurdjura north western. At cone level the results revealed a positive correlation between cone weight and seed weight indicating that heavy cones bear heavy seeds, while other parameters did not show particular relationships. These results suggest that during harvesting forest-

ers cannot rely on cone weight as a good predictor of seed amount and germination. At tree level the results did not show any trade-offs between seed traits (for example weight and number) and number of cones produced by a tree. The advantage for any tree of being highly fertile in terms of number of cones produced is not particularly combined to additional advantage in terms of high number of seeds contained in these cones.

F. Krouchi, Laboratoire de Biosystematique forestière, Faculté des Sciences Agronomiques et Biologique, Université Mouloud Mammeri (Tizi-Ouzou, Algérie), E-Mail : krouchi@yahoo.com; A. Derridj, Laboratoire de Biosystematique forestière, Faculté des Sciences Agronomiques et Biologique, Université Mouloud Mammeri (Tizi-Ouzou, Algérie). Received 4 June 2003.

## Variation in Cone and Seed Traits Among Provenances of *Cedrus atlantica* Manetti in Algeria

A. Derridj and F. Krouchi

### ABSTRACT

Cones and seeds were studied on 11 provenances of *Cedrus atlantica* in Algeria during two consecutive years. During 1986 we analysed seed dimensions, amount of filled seeds and weight of 1000 seeds. During 1987 we measured the following parameters: cone dimensions and weight, total number of seeds in 100 cones, amount of filled seeds in 100 cones, weight of the total number of seeds, weight of 1000 filled seeds, number of filled seeds per hectolitre of cones, weight of filled seeds per hectolitre of cones. The results obtained are discussed in regard to geographical range of the provenances and their potential to provide seeds for reforestation programs.

A. Derridj, Laboratoire de Biosystematique forestière, Faculté des Sciences Agronomiques et Biologique, Université Mouloud Mammeri (Tizi-Ouzou, Algérie); F. Krouchi, Laboratoire de Biosystematique forestière, Faculté des Sciences Agronomiques et Biologique, Université Mouloud Mammeri (Tizi-Ouzou, Algérie), E-Mail: krouchi@yahoo.com. Received 4 June 2003.

## A Conservation Strategy for Dwarf Birch (*Betula grandulosa* Michx.) a Species of Concern in New Brunswick

K. Forbes\*, T. Beardmore

### ABSTRACT

Dwarf birch (*Betula grandulosa* Michx) has been identified as a species of concern in New Brunswick because current knowledge of the reproductive capability of this species is unknown. The reproductive capability of this population and the quality of the seed produced was assessed. The X-ray results indicate that 31 of the 37 shrubs had 70–98 % of filled seed (endosperm completely

fill the seed), 31 of the 37 shrubs had 0–20% undeveloped seed, 28 of the 37 shrubs had 0–10% empty seed present in the sinker seed fraction. The total reproductive biomass (bracts, central axis, seeds), had the majority of the sample weight in either the empty or bract/axis category (31 of 37 shrubs had 30–50% in the empty category, 31 of 37 shrubs had 50–70% in the bract rachis/axis,). Therefore these two categories accounted for upwards of 90% of the total sample weight for most shrubs. The ratio of floater to total sample weight ranged from 0.1–8.0%. Reproductive efficiency, the ratio of filled to total sample weight was low ranging from 0.0–0.2%. Percent germination was over 60% in 32 of the 37 shrubs. Percent germination for all the shrubs decreased and mean germination time increased over the low temperature tolerance treatments (stored at 5 °C for 1 year and placed at –20, –80 and –196 °C). More work in identifying optimal seed storage conditions for this species is needed to develop a conservation strategy This study provides a baseline of information on dwarf birch seed in New Brunswick.

K. Forbes\*, NRCan, Canadian Forest Service, Hugh John Fleming Forestry Complex, PO 4000, Fredericton, New Brunswick, Canada, E3A 5P9; T. Beardmore, NRCan, Canadian Forest Service, Hugh John Fleming Forestry Complex, PO 4000, Fredericton, New Brunswick, Canada, E3A 5P9. \*Corresponding author. Received 4 June 2003.

## Induction of Tolerance to Desiccation and Cryopreservation in Silver Maple (*Acer saccharinum*) Embryonic Axes

T. Beardmore\* and C. Whittle

### ABSTRACT

Mature silver maple embryonic axes were treated with abscisic acid (ABA) and/or tetracyclis (TC) to examine the effect of these treatments on the axes tolerance to desiccation and cryopreservation. Axes were placed on nutrient media containing 0, 20 or 60  $\mu\text{M}$  ABA and/or  $10^{-6}$  M TC for 2 weeks, after which axes were removed from the media and desiccated to approximately 10% water content. After desiccation all ABA- and/or TC-treated axes exhibited root growth ranging between 12 and 97% when placed on growth media, and only 97, 63 and 22% of the desiccated 20 and 60  $\mu\text{M}$  ABA/ $10^{-6}$  M TC- and  $10^{-6}$  M TC-treated axes exhibited shoot growth, respectively. In addition, 55 and 43% the desiccated 20 and 60  $\mu\text{M}$  ABA/ $10^{-6}$  TC-treated axes germinated after cryopreservation. The control axes (desiccated immediately after seed collection) did not tolerate desiccation or cryopreservation. ABA content was examined in the embryonic axes and it was found that only the 20 and 60  $\mu\text{M}$  ABA/ $10^{-6}$  M TC-treated axes maintained a high ABA content (57 and 62 pmole ABA/embryo, respectively) before and after desiccation. The ABA content of all other treated axes declined to 31 pmole/embryo and lower. These results suggest that inhibiting ABA degradation may have a role in

developing tolerance to desiccation in silver maple axes, and that ABA/TC treatment of axes may be useful for the long-term storage of axes.

T. Beardmore\*, NRCan Canadian Forest Service-Atlantic Region, HJF Forestry Complex, P.O. 4000, Fredericton, New Brunswick, E3A 5P7, Canada; C Whittle, Department of Biology, Dalhousie University, Halifax, Nova Scotia, B3H 4H6, Canada. \*Corresponding author. Received 4 June 2003.

## Effect of Soaking, Moist Chilling, and Temperature on Germination of *Acer pensylvanicum* Seed

A. Bourgoïn and J.D. Simpson\*

### ABSTRACT

Five seed lots of *Acer pensylvanicum* L. were used to evaluate the impact on germination of: soaking duration, moist chilling time, and germination temperature. Seeds were soaked for 0, 48, 72, and 96 hours prior to moist chilling for 16, 24, and 32 weeks. Diurnal germination temperatures of 5 °C for 16 hours/15 °C for 8 hours plus light (5 °C/15 °C) and 20 °C for 16 hours/30 °C for 8 hours plus light (20 °C/30 °C) were used. Soaking and chilling seeds significantly increased germination. Germination at 5 °C/15 °C was highest, but the germination rate was slow. Germination at 20 °C/30 °C was lower but 94–98% of ungerminated seeds were still alive, suggesting they were dormant. Overall results showed that soaking seeds for 48 hours, moist chilling for 16 weeks, and germinating at 5 °C/15 °C produced an average germination of 92%.

A. Bourgoïn, Department of Natural Resources and Energy, PO Box 6000, Fredericton, NB, E3B 6H6, Canada; J.D. Simpson, Natural Resources Canada, Canadian Forest Service, PO Box 4000, Fredericton, NB, E3B 5P7 Canada. \*Corresponding author (dsimpson@nrcan.gc.ca). Received 4 June 2003.

## Maturity and Temperature Stratification Affects the Germination of *Styrax japonicus* Seeds

Mark S. Roh\*, Jo-Ann Bentz, Paul Wang, Ercheng Li, Masaji Koshioka

### ABSTRACT

The effect of seed maturity, warm (18 °C) or cold (5.5 °C) stratification, and gibberellic acid (GA<sub>3</sub>) on *Styrax japonicus* seed germination was investigated. Seed maturity and morphological changes were observed using magnetic resonance imaging (MRI). Fruits harvested on July 22, 8 weeks after flowering, showed early development of cotyledons and endosperm, but seeds failed to germinate. Seeds harvested 11 to 13 weeks after flowering formed cotyledons and endosperm by MRI, indicating that they were mature. Internal seed structures were identified using MRI and showed tissues that contained water with different mobility in early growth stages. The endosperm of

immature seeds had low water mobility, while developing cotyledons had high water mobility. While the water mobility in the seed coat declined, the pericarp maintained high water mobility. In the pericarp,  $T_1$  was increased with maturation of the seed, indicating the termination of the physiological role of the pericarp. Germination increased when cold stratification (CS) was given after 1 month of warm stratification (WS). The maximum percent germination was 98%, after 2 months of WS followed by 3 months of CS. Treating seeds with  $GA_3$  at 3,000 or 6,000 ppm promoted germination, as compared to seeds treated only with CS.

Mark S. Roh\*, USDA, ARS, USNA, Floral and Nursery Plants Research Unit, Beltsville, MD 20705, USA; Jo-Ann Bentz, USDA, ARS, USNA, Floral and Nursery Plants Research Unit, Beltsville, MD 20705, USA; Paul Wang, Howard University, University Hospital, Radiology Department, Washington, D.C., USA; Ercheng Li, Howard University, University Hospital, Radiology Department, Washington, D.C., USA; Masaji Koshioka, National Agricultural Research Organization, National Institute of Floricultural Science, Department of Genetics and Plant Physiology, Tsukuba, Ibaraki, Japan. \*Corresponding author. Received 4 June 2003.

## Longleaf Pine Seed Health: Efficacy of Chemical Treatments

James P. Barnett

### ABSTRACT

The demand for longleaf pine (*Pinus palustris* Mill.) seed has increased at least 10 fold in the last few years due to emphasis on restoring this ecosystem. One of the limitations in increasing longleaf pine seedling production has been the limited availability of quantity seeds. Longleaf pine seeds have large, thin and fibrous coats that carry significant populations of microorganisms. Many of the fungi carried on the seeds are pathogenic during germination and early seedling establishment. Seed processors and nursery managers continue to seek alternative methods to reduce losses due to infestations of seed pathogens. Container production is now the preferred method of growing seedlings and container stock is several times as costly as bareroot nursery seedlings. So, availability of high quality seed is an important consideration in minimizing seedling cost, as well as in meeting demands for planting stock.

Pathological evaluations of longleaf seeds, both earlier and current, indicate that *Fusaria* represent one of the major seedborne pathogens. Studies show that both appropriate sterilants and fungicides will reduce pathogens and result in improved germination and seedling establishment. The results from a number of chemical treatments will be presented and discussed.

James P. Barnett, USDA Forest Service, Southern Research Station, 2500 Shreveport Hwy., Pineville, LA 71360. Received 4 June 2003.

## Improvement in Storability of Ashwagandha (*Withania somnifera* Dunal) Seeds Through Pre-storage Treatments by Triggering Their Physiological and Biochemical Properties

V. Vakeswaran and V. Krishnasamy

### ABSTRACT

Ashwagandha (*Withania somnifera* Dunal) is an important medicinal plant cultivated in India, which is propagated mainly through seed. Seed germination decreases initially by 40–50% and at the end of one year 5% of the seeds germinate. Leaves of *Azadirachta indica* (neem), rhizome powder of *Curcuma longa* (turmeric) and *Acorus calamus* (vasambu) have been reported to possess anti-insect properties. Leaf powder of *Albizia amara* (arappu) has been reported to improve the germination of stored seeds. Acetyl salicylic acid is an antioxidant. Halogenation with iodine helps to stabilize the lipoprotein membranes. Keeping these in view, graded seeds were subjected to pre-storage treatments with leaf powders of neem and arappu, rhizome powder of turmeric and vasambu, acetyl salicylic acid and iodination, and stored in 700 gauge polyethylene bags. Bimonthly evaluations were made on seed germination, seedling growth and biochemical attributes viz., protein, enzymes (amylase and catalase), lipid peroxidation and electrical conductivity. Iodination was better in controlling seed deterioration process. The physiology and biochemistry of improvement in storability are discussed.

V. Vakeswaran and V. Krishnasamy, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India. Received 4 June 2003.

## Effect of Seed Priming in Pea (*Pisum sativum* L.) Seeds

V. Vakeswaran, A. Vijayakumar and R. Jerlin

### ABSTRACT

The technique of hydration and dehydration was adopted to improve the germinability and vigour of 8-month-old seeds of pea cv. Bonneville. These seeds were soaked in a solution of  $10^{-3}$  M oxalic acid for 6 hours and dried to their original weight in order to improve the germination and seedling vigour. The percentage increase in germination was 32.0% over the control, water soaked and dried seeds. Other chemicals such as tannic acid, sodium dihydrogen phosphate (hydrated), disodium hydrogen phosphate, sodium chloride and boric acid were also tested, but these seed treatments did not increase the germination or seedling vigour. Sodium chloride ( $2 \times 10^{-4}$  M) treatment decreased the germination and seedling vigour in both fresh and old seeds.

V. Vakeswaran and V. Krishnasamy, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India. Received 4 June 2003.

## Standardization of Germination Test Procedure in Ashwagandha (*Withania somnifera* Dunal)

V. Vakeswaran and V. Krishnasamy

### ABSTRACT

Ashwagandha (*Withania somnifera* Dunal), Family Solanaceae is an important cultivated medicinal plant of India, which is grown for its roots. The purpose of this work was to determine the optimal germination conditions for this species. Four replicates of 100 seeds each were exposed to varying germination temperatures [ $T_1$ : 20 °C constant;  $T_2$ : 25 °C constant;  $T_3$ : 30 °C constant;  $T_4$ : 20 and 30 °C (16 h and 8 h, respectively) and  $T_5$ : 25 and 30 °C (16 h and 8 h, respectively)], and germinated on different substrates [sand (S), roll towel (RT) and top of paper (TP)]. The germinating seed at 25 and 30 °C on top of paper resulted in the shortest time required for germination (4.0 days) and the highest germination (63.0%), rate of germination, root (2.6 cm) and shoot (2.94 cm) length of seedlings and vigour index. Twenty three percent of radicles emerged four days after seeds were imbibed and the maximum number of germinants was obtained 12 days after imbibition (62%) and this remained high until 17 days after imbibition at which time seedlings started to die. By 18 days after imbibition mortality was 2% and increased as seeds were further imbibed. It is concluded that ashwagandha seeds should be exposed to alternating temperature of 25–30 °C and placed on top of paper medium for conducting the laboratory germination tests.

V. Vakeswaran and V. Krishnasamy, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India. Received 4 June 2003.

## Physiological and Biochemical Changes During Seed Development and Maturation in Ashwagandha (*Withania somnifera* Dunal)

V. Vakeswaran and V. Krishnasamy

### ABSTRACT

Seed crop of Ashwagandha (*Withania somnifera* Dunal) was raised during March, 2000 in four beds of size 3 x 2 m<sup>2</sup> to form four replications at Tamil Nadu Agricultural University farm, Coimbatore. About 250 flowers were tagged at the time of anthesis with the detail of date of flowering in each replication. Sufficient number of fruits were collected at seven days interval from the date of tagging viz., 7, 14, 21, 28, 35 and 42 days after anthesis (DAA). The fresh and dry weight of seed attained maximum values at 35 DAA, recording 5.6 and 2.3 mg 10 seeds<sup>-1</sup>, respectively and decreased thereafter. Physiological maturity is normally defined as the stage at which the

seed attain its maximum dry weight. Seeds could germinate at the earlier stages of development, however germination increased with increasing maturity of seed. Maximum germination was 63.5% 42 DAA. Maximum electrical conductivity of seed leachate ( $0.980 \text{ dSm}^{-1}$ ) occurred at seven days after anthesis and as maturity advanced this value decreased and was the lowest 42 DAA ( $0.069 \text{ dSm}^{-1}$ ) at 42 DAA. The highest activities of  $\alpha$ -amylase and catalase occurred at seven days after anthesis in the developing seed, which coincided with the highest moisture level. Thereafter, the activities of both the enzymes reduced and reached the lowest level at 42 DAA.

V. Vakeswaran and V. Krishnasamy, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India. Received 4 June 2003.

## **Effect of Boron on Seed Yield and Resultant Seed Quality in Pea (*Pisum sativum* L.)**

V. Vakeswaran, A. Vijayakumar and R. Jerlin

### **ABSTRACT**

A field experiment was conducted to study the effect of boron on seed yield and its influence on the resultant seed quality in pea (*Pisum sativum* L.). Aqueous solution of borax in different concentrations (1000, 2000, 3000, 5000 and 7000 ppm) were sprayed at flowering stage. Observations were made on number of pods/plant, pod yield/plant, number of seeds/pod, seed yield/plant, shelling outturn, and 100 seed weight. The results indicated that all the parameters were found to increase with the increasing rates of borax application. Harvested seeds were then analyzed for their physiological and biochemical characteristics. Percentage germination, seedling dry matter production, vigour index, electrical conductivity, protein content and free amino acids exhibited positive relationship with the increased application of borox.

V. Vakeswaran and A. Vijayakumar and R. Jerlin, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India. Received 4 June 2003.

## **Quantitative and Qualitative Changes in Seed Quality During Seed Development and Maturation in Pea (*Pisum sativum* L.)**

V. Vakeswaran, A. Vijayakumar and R. Jerlin

### **ABSTRACT**

This study was designed to assess the quantitative and qualitative changes in pea (*Pisum sativum* L.) seed quality during seed development and maturation, and to identify when seeds are mature. A field trial was conducted with pea cv.

'Bonneville' and seeds were harvested in 7-day intervals from the starting of flowering. Seeds were assessed for various parameters in the laboratory. Seed dry weight attains a maximum value 49 days after anthesis (DAA) and therefore seeds at this stage in development are considered to be mature. Seed moisture content at this stage was 30%. The onset of ability to germinate occurred in 21 DAA. Maximum seedling dry weight and vigour index occurred in 49 DAA. Electrical conductivity and free amino acid content decreased with increasing seed maturation, while seed protein content increased with seed maturation.

V. Vakeswaran and A. Vijayakumar and R. Jerlin, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India. Received 4 June 2003.

## Effect of Spacing and Fertilizer Level on Growth, Seed Yield and Resultant Seed Quality in Pea (*Pisum sativum* L.) cv. Bonneville

V. Vakeswaran, A. Vijayakumar and R. Jerlin

### ABSTRACT

The treatments with four spacings (2.5, 5.0, 7.0 and 10 cm between plants and a uniform spacing of 40 cm between rows) and three levels of NPK fertilizers (80:60:50; 120:80:70 and 160:100:90 kg/ha) applied to a seed crop of pea (*Pisum sativum* L.) cv. Bonneville. The effect of these treatments on days to first flowering, plant height, number of pods/plant, pod yield/plant, number of seeds/pod, seed yield/plant, shelling outturn and 100 seed weight were evaluated. All the parameters were significantly influenced by spacing and fertilizer levels. With every increased level of NPK fertilizer and spacing, generally these characters showed favorable response. Germination potential, seedling growth, vigour index, dry matter production, electrical conductivity, protein content and free amino acids of the resultant seeds also have positive association with increased fertilizer levels and spacing.

V. Vakeswaran and A. Vijayakumar and R. Jerlin, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India. Received 4 June 2003.

## Technology for Synthetic Seed Development in Aswagandha (*Withania somnifera* Dunal)

V. Vakeswaran and V. Krishnasamy

### ABSTRACT

The methodology for producing artificial Ashwagandha (*Withania somnifera* Dunal) seeds was investigated. The leaf explants were placed on the MS medium supplemented with 2, 4-D (4 mg/l), kinetin (0.2 mg/l) and CH

(500 mg/l) to induce callus formation. Callus was then transferred to several combinations of media compositions in order to induce somatic embryo production. MS medium supplemented with 2, 4-D (0.5 mg/l), kinetin (0.2 mg/l), BAP (1 mg/l) and CH (500 mg/l) was found to be optimal for somatic embryo production. Sodium alginate at 3% in combination with calcium chloride at 1%, produced stable beads which were used to encapsulate the somatic embryos. To maximize the germination of the encapsulated somatic embryos, the use of an artificial endosperm was examined. It was found that encapsulating the somatic embryos with half strength MS medium, BAP (2mg/l), IBA (0.2mg/l), activated charcoal (0.1mg/l) and bavistin (0.5mg/l) improved somatic embryo germination.

V. Vakeswaran and V. Krishnasamy, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India. Received 4 June 2003.

## **Influence of Plant Growth Regulators in Germination of *Withania somifera* Dunal Seeds**

V. Vakeswaran and V. Krishnasamy

### **ABSTRACT**

The influence of plant growth regulators like gibberellic acid ( $GA_3$ ), indole butyric acid (IBA) and indole acetic acid (IAA) on the ashwagandha (*Withania somifera* Dunal.) seed germination was studied.  $GA_3$  was found to be more effective in improving the seed germination in ashwagandha than either IBA or IAA.

V. Vakeswaran and V. Krishnasamy, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India. Received 4 June 2003.

## **Mid-storage Correction to Prolong Shelf Life of Seeds in Sunflower (*Helianthus Annuus* L.) Hybrid KBSH-1 and Parental Lines**

P. R. Renganayaki\* and V. Krishnasamy

### **ABSTRACT**

A study was conducted at Tamil Nadu Agricultural University, Coimbatore, during February, 2000, to evaluate the effect of mid-storage correction (hydration-dehydration treatment) in prolonging the shelf life of seeds during storage in sunflower (*Helianthus annuus* L.) hybrid KBSH-1 and its parental lines. The longevity of seeds in storage is largely influenced by the genotypes, history of seed taken to storage, moisture content of the seed, container in which it is packed, and temperature of storage environment.

The study revealed that four month old seeds soaked in butylated hydroxy

toluene ( $10^{-4}$  M) and sodium dihydrogen phosphate ( $10^{-3}$  M) for two hours and dried back to original moisture content, maintained better germination and vigour during subsequent storage. The hybrid exhibited better response to the mid storage seed treatments than did its parental lines. The rate of seed deterioration during storage was lower in the hybrid than other genotypes.

P. R. Renganayaki,\* Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003; V. Krishnasamy, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore – 641 003. \*Corresponding author. Received 4 June 2003.

## Preliminary Studies on Seed Longevity of *Pongamia pinnata*

Maitreyee Kundu\*

### ABSTRACT

The seeds of *Pongamia pinnata* were stored at four moisture contents of 4.5 to 11.8% and four temperatures of  $-20$  to  $15$  °C. Seeds were sampled at intervals up to three years for assessment of germination capacity and viability equations were used to express the relationship between storage conditions and viability of seeds. Drying the seeds to 4.5% moisture content did not affect the germination and the seeds can best be stored at 4.5% moisture content and  $-20$  °C, therefore supporting the orthodox nature of the seeds of this species. The upper moisture limit is very low (12%). The relation between upper limit and oil content of seeds has been discussed.

Maitreyee Kundu Rain Forest Research Institute, P.O. Box 136, Jorhat 785001 Assam, India, rainfor@sancharnet.in \*Corresponding author. Received 4 June 2003.