東洋資源植物學會誌 J.Oriental Bot. Res. 3(1) 31 ~ 40(1990)

# Seedcoat removal and seed germination in *Helianthus tuberosus* L.

K.B. Lim,* H.J.Lee,** S.R.Lee*** J.I.Lee**** and S.D.Ahn****

* *Livestock Experiment Station*
** *Seoul Na'tl Univ.*
*** *Tokyo Agricultural Univ.*
**** *Suncheon Na'tl Univ.*

# 種皮除去와 돼지감자種子의 發芽

임근발,* 이호진,** 이상래,*** 이종일,**** 안상득 ****

* 축산시험장
** 서울대학교
*** 동경농업대학
**** 순천대학

## Abstract

Pericarp and seedcoat removal treatments were tested to determine their effectiveness in the hard-to-germinate botanical seeds of jerusalem artichoke. Fresh seed of five *Helianthus tuberosus* L. varieties were (A) untreated (B) water soaked overnight (C) soaked overnight followed by removal of pericarp or (D) soaked overnight followed by removal of pericarp and seedcoat. The results indicate that treatments which removed the pericarp and seedcoat were the

very effective, giving germination of over 90%. A considerable increase in germination did not follow only the pericarp removal treatments. The factors inhibitory to germination of fresh jerusalem artichoke seed is associated with the seedcoat. The removal treatment of pericarp and seedcost is recommended despite its complexity because it gives a high germination percentage and varies least from variety to variety.

---

Additional index words: Seed treatments, Germination inhibitor, Pericarp, Seedcoat, Jerusalem artichoke. Biomass.

*Helianthus tuberosus* L., a biomass potential crop, is a member of the family compositae. The genus *Helianthus* has provided man with two food plants, the sunflower (*H. annus*) and the jerusalem artichoke or topinambour (*H. tuberosus*). (3) The jerusalem artichoke grown for its tubers, has always been an extremely minor crop, but it is still grown in many places as a food for man or livestock and for the production of alcohol. Though tubers are used for propagation jerusalem artichoke also flower and produce seed in head-like in florescences. Flowers are developed acropetally on flattened receptacles such that outermost flowers are oldest. Each of these epigynous flowers may develop an achene-type fruit in which outer layers of the overy wall persist, while inner layers become disorganized. Inside the ovary wall of mature fruit, there is a papery seedcoat, probably composed of compact cells from endosperm, integuments, and nucellus.

In general, the efforts to improving this crop have been hampered by the hard-to-germinate botanical seed. Seeds did not germinate for at least 11 months after harvest. Fresh seeds of some varieties require one year more to germinate. (5) Since the time factor between generations is of concern in a prospective breeding program of jerusalem artichoke, these observations led to investigation of the nature of delayed seed germination in jerusalem artichoke as a biomass potential crop.

## Material and Methods

Seeds from the following *Helianthus tuberosus* varieties were used: JA6, Mammoth French White, JA2, D-19 and K-8. Seeds were harvested November 10, 1988, from plants grown in the field and stored at room temperature, 18-25°C. Samples of 50 seeds from each variety were subjected to the following treatments on March 5 and on March 24, 1989: (A) control or no treatment (B) Soaked overnight. (C) Soaked overnight followed by removal of the pericarp and seedcoat. Seed soaking was done in a petri dish containing 50ml of distilled water.

To remove the pericarp, it was split at anterior end of each seed with hands and stripped off in sections. When both pericarp and seedcoat were removed, they were split and peeled away from the anterior end. Embryo tissue was ejected by squeezing the posterior end.

The treated seeds were subsequently placed in petri dishes on filter paper soaked with distilled water and incubated in box-type Livenberg germinator, held at $20 \pm 5$ °C. Continuous light was supplied by a 60 watt incondescent bulb to promote normal growth. Seedlings were floated out and counted after 7 days in the germinator. Shoot length were measured also.

From germination data, estimation for two variables were computed; percent germinated seed and mean shoot length of germinated seed for estimating effects of treatments on seed germination and early growth of seedlings. Arcsin of the square root of percent germination was used for analysis of this variable. A three-factor analysis of variance was done using the model:

$$Y_{ijk} = \mu + r_i + s_j + rs_{ij} + t_k + rt_{ik} + st_{jk} + E_{ijk}$$

Where $r_i$ = the $i^{th}$ reprication, $s_j$ = the $j^{th}$ *H. tuberosus* variety, and $t_k$ = the $k^{th}$ treatment. Varieties were considered random, treatments and replications fixed. The error term was used to test two-factor interaction terms involving replications. These were non-significant, so were pooled with error for lesting variety and variety by treatment interaction effects. Other main effects were tested with appropriate interaction mean squares.

## Results and Discussion

As indicated in the analysis of variance (Table 1) the treatments effected both seed germination and shoot growth. Since neither main effects due to variety nor interaction effects of variety with treatments were significant, indications were that inhibition to germination was similar in each variety. However, in field tests, D-19 and JA6 germinated better than Mammoth French White and JA2, when seeds had been stored at room temperature for 17 months to two year (5) sugesting that genetic differences may exist for inhibition to seed germination.

Table 1. Analysis of variance for effect of seed dehulling treatments on seed germination in *H. tuberosus*

| Source of variation | df | Mean square for response variable | |
|---|---|---|---|
| | | Mean shoot length+ | Arcsin of percent germination |
| Date (D) | 1 | 163.4 | 54.6 |
| Varieties(V) | 4 | 140.6 | 96.7 |
| Treatments | 3 | 2005.9* | 14009.9** |
| V × T | 12 | 263.9 | 82.6 |
| Residual | 19 | 283.2 | 107.8 |

* Significant at .05 level

** Significant at .01 level

\+ Mean shoot length of germinated seed.

Treatment effects were striking on both seed germination and seedling growth. (Fig. 1) The level of germination found in the seedcoat removal was suprising since Heiser *et al* (4) consider this to be one of the most difficult to germinate species. Germination did not increased beyond that of untreated seed after removal of the pericarp material only. (Fig. 2)

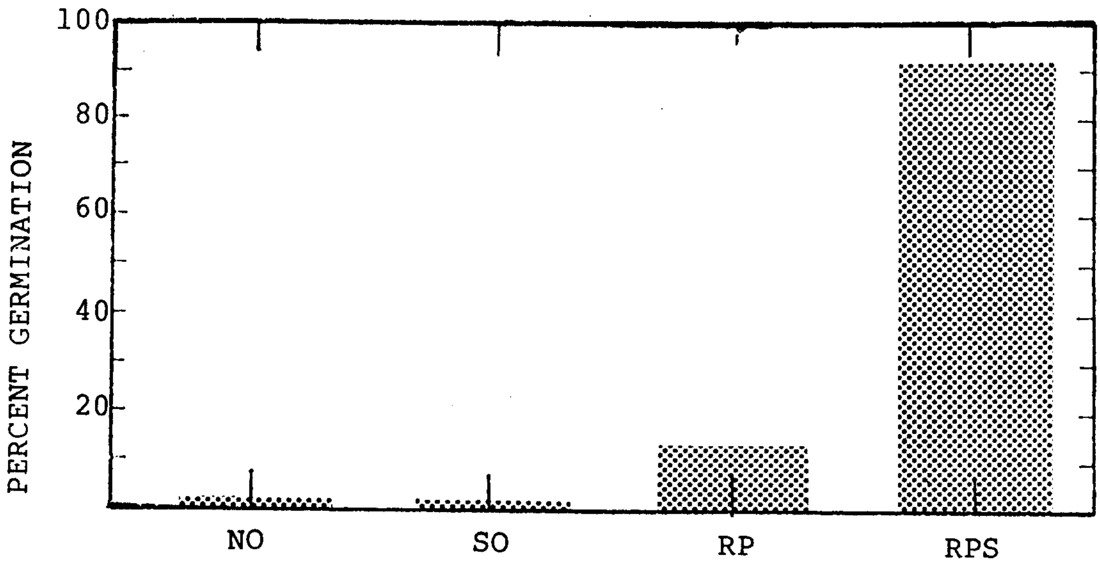


Fig.1 Effects of seed treatments on seed germination in a composite of five *H. tuberosus* varieties

NO : No treatment

SO : Soaked overnight

RP : Soaked overnight followed by removal of the pericarp

RPS: Soaked overnight followed by removal of the pericarp and seedcoat.

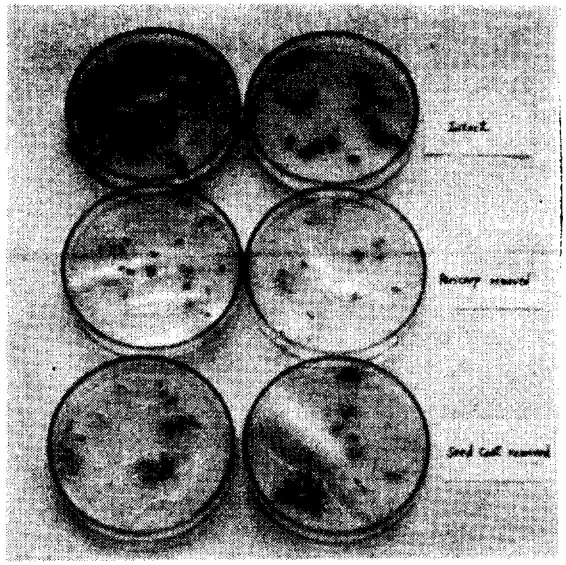

Fig.2 Effects of seed coat removal treatments on the germination of seeds from *Heliantus tuberosus* L. var. JA6

Since neither variety nor interaction effects, data for each treatment were pooled. For pooled samples 239 seed of 250 germinated when pericarp and seedcoat removed, compared to 36 when only the pericarp was removed. The Chi-square value obtained, testing the hypothesis of no difference due to treatment, was significant at the .01 level. Not only did removal of both pericarp and seedcoat result in increase in seeds germinated, but most seedlings were normal in appearance.

*H. tuberosus* is cross fertile.(1) Seeds that germinate readily may be from chance cross pollinations, therefore different in genotype from others. But the variable response of varieties to the pericarp and seedcoat removal treatment lead us to this treatment as the best method for breaking hard-to-germinate trait in the botanical seed of *H. tuberosus*.

Results obtained suggest that the factors inhibitory to germination is located in the seedcoat. These data also indicate inhibition may be physical rather than chemical since increased seed germination observed following pericarp removal could probably be attributed to damaged seedcoats, even though seedcoats appeared to be intact. However, it should be noted that this experiment was not designed to exclude chemical inhibitors as possible retardant to germination of freshly harvested seeds.


## 摘 要

植物學的 種子 (botanical seed)에 의한 돼지감자의 實生繁殖을 시도하였다. J- A2等 5種 돼지감자의 花器에서 種子를 채취하여 室內에 보관하여 오면서 發芽를 誘導하였으나 저장期間이 4個月 되는時期까지 發芽시킬 수 없었다. 그러나 種子의 果皮(pericarp)와 種皮(seed coat)를 모두 除去하는 處理에서 完全한 發芽誘導가 可能하였는데 特히 種子의 果皮除去만으로는 發芽誘導效果를 볼 수 없었다. 이러한 結果로 부터 돼지감자의 植物學的 種子의 경우 種子의 種皮가 種子의 不發芽에 깊이 관련되어 있음을 확인할 수 있었다. 또한 돼지감자 種子의 種皮除去에 의한 發芽誘導方法은 수집種에 따른 차이 없이 어느 種에서나 發芽誘導에 매우 效果的이었다.

## Literature cited

(1) Allard, R.W. (1960) Principles of plant breeding. John Wiley & Sons, Inc.

(2) Chandler, J.M. and C.C. Jan (1985) Comparison of germination techniques for wild *Helianthus* seeds. Crop Sci. Vol. 25 pp.356-358.

(3) Heiser Jr, C.B. (1976) Sunflowers. In evolution of crop plants. N.W. Simmonds edit. p.37. Longman (London and Newyork) Press.

(4) Heiser, C.B., Jr. (1976) The sunflower. University of Oklahoma Press, Norman.

(5) Lim, K.B. (1988) Studies on germination of seed and growth characteristics of seedling in jerusalem artichoke (*Helianthus tuberosus* L.) pH.D thesis, Seoul Na'tl Univ.