BASSWOOD (*TILIA AMERICANA L.*) SEED GERMINATION

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Basswood seed has held the interest and caused the frustration of plant propagators for many years (1,2,4). This presentation is limited to American basswood (*Tilia americana* L.) seed. The seed is borne within a tough indehiscent pericarp and has a crustaceous testa, a fleshy, yellowish endosperm, and a well-developed embryo. The seed normally matures in mid to late September, but may hang on the tree into winter. Since basswood seed persists on the tree, seed collection is often postponed until long after maturity.

It was reported about basswood seed nearly 50 years ago (3) that "the germ must have a year at least on the ground among the leaves and damp mold to ripen. In planting them it is, therefore, necessary to wait until the second spring for their germination." More recently, the summary of basswood germination in *Seeds of Woody Plants in the United States* (5) stated that "seed treatments that consistently result in good germination have not been developed." Certainly these reports document the problem of basswood seed germination and reflect past results obtained from my own Institute.

The first step in our investigation of the basswood seed germination problem was to determine the effect of seed maturity at harvest on subsequent germination of seed from a tree of local source. Seed was harvested weekly (Table 1) beginning while the pericarp was still green, the endosperm was milky and the embryo was immature. As the season progressed, ontogenetic changes occurred. The pericarp became grayish-brown and woody, the endosperm became dry and yellowish, and the embryo grew and became differentiated. Some of this seed was sown outdoors as soon as it was harvested. Germination was recorded the first spring and the results are presented in Table 1. Germination from the August 12, 19, and 26 harvest dates was 10%, 8% and 12%, respectively. Germination from September 2 improved to 21%; 51% germination was obtained from September 9 harvest date and, thereafter, germination was extremely poor. Similar seed lots were sown in the greenhouse and there, too, best germination was obtained from seed which had been harvested and sown on September 9. It may be asked, "is there something special about the date, September 9?" Of course not. These results indicate, however, that some special physiological state favouring germination existed in seed harvested at that stage of maturity.

Table 1. Spring germination of fall-sown American basswood seed.

Date of Harvest and Sowing	Germination Percentage	Seed Moisture (Percent Dry Weight)	Pericarp Colour (Percent Grayish-Brown)
August 12, 1977	10	61	0
August 19, 1977	8	60	0
August 26, 1977	12	57	44
September 2, 1977	21	27	94
September 9, 1977	51	16	100
September 16, 1977	6	7	100
September 23, 1977	1	9	100

Our next step was to record the moisture content of the seed and the colour of the pericarp during the consecutive weeks of harvest. These factors were evaluated for usefulness in indicating the ideal harvest date. The moisture content remained nearly constant at 60% for the first three harvests. It then dropped rapidly to below 10% during the next three weeks and remained at that level. The ideal stage of maturity occurred during the time when moisture was being lost rapidly from the seed. The actual seed moisture content on September 9 was 16%. This indicator could be used to measure maturity. Unfortunately it would take a considerable effort and require an expensive balance for measuring the weights. Alternatively, the colour of the pericarp is easily and inexpensively observed. It also appears to be a definitive characteristic. Once the color change of a pericarp began it proceeded very quickly, so that green pericarps were easily distinguished from grayish-brown pericarps. The ideal date of harvest occurred at the time when 100% of the pericarps had turned grayish-brown. There is good uniformity of ripening on any individual tree. The exact date of ripening may vary by several weeks among trees.

Having established that there is a very specific stage at which basswood seed should be harvested for subsequent ease of germination and that the colour of the pericarp indicates that stage, one might ask what part of the seed structure promotes or permits germination at that stage and not at some other stage of maturity. There are really two possible causes of dormancy. One cause is from a physical restriction such as might be imposed by the pericarp or the testa. The other possible cause of dormancy lies physiologically within the endosperm or the embryo.

The possibility of the pericarp causing restriction to germination was tested by comparing germination of whole versus de-pericarped seed in the greenhouse. The results, shown in Table 2, indicate that the whole seed germinated just as well as the de-pericarped. It would seem then that the pericarp did not restrict germination despite its woody structure. The effect of

the testa on germination has been evaluated on the basis of a simple observation. Seeds were placed in water at each harvest date. The seeds harvested August 12 through September 9 imbibed completely within 24 hours. Seeds harvested September 16 and 23 did not imbibe even after being in water for one week. Since the date when seeds failed to imbibe coincided with the date when germination became poor, it would seem that the testa was restricting germination. Undoubtedly there is another barrier to germination as well because prompt germination of basswood seed did not occur when it was harvested and sown at a stage of maturity when the testa was not restrictive.

Table 2. Germination of greenhouse-sown American basswood seed.

Date of Collection and Sowing	Percent of Germination	
	Whole	De-pericarped
August 12, 1977	—	12
August 19, 1977	9	11
August 26, 1977	28	47
September 2, 1977	32	23
September 9, 1977	53	32
September 16, 1977	—	29
September 23, 1977	8	5

Internal barriers to seed germination were examined by aseptically removing embryos from the testa and endosperm and placing these on agar culture medium containing nutrients but no hormones. At each harvest date the embryos promptly began growing and developed as normal seedlings. If the endosperm, or even a part of the endosperm, was left around the embryo, no growth took place. These tests indicate an apparent lack of embryo dormancy since the naked embryo will grow when it is separated from other components of the seed. Some factor restricting germination seems to be present in the endosperm which must be overcome before germination of an intact seed can occur. That factor would normally be overcome through stratification.

How then should basswood seed be handled in nursery practice? The most reliable procedure for propagators who collect their own seed is to monitor the pericarp color as the seeds are maturing and collect the seed when nearly all of the pericarps have turned from green to grayish-brown. The freshly harvested seed should be sown promptly into a well-prepared seed bed. The seed bed should be mulched well, protected from rodent damage and kept moist until germination begins in the spring.

Late-harvested seed may also be germinated the first season but it requires more treatment than seed harvested at the ideal stage of maturity. Good germination (68%) was obtained in one

of our studies but the pre-germination treatments involved pericarp removal, scarification and stratification (Table 3). The seed was first de-pericarped mechanically using a modified buckwheat de-huller. Removal of the pericarp exposed the testa. The exposed testa was scarified using concentrated sulfuric acid for 20, 30 or 45 minutes. Following scarification, the seed was stratified at 5°C for 7½ months in peat moss/sand (1:1) containing 30% moisture by weight. Stratified seed was beginning to germinate when it was sown on May 25. Further studies are underway to establish the consistency of that treatment.

Table 3. Germination of de-pericarped American basswood seed.

Pre-germination Treatments		Sowing Time	Germination Percentage
H_2SO_4	Stratification		
1. none	none	fall	—
2. 20 min.	none	fall	6±1
3. 30 min.	none	fall	5±1
4. 45 min.	none	fall	2±1
5. none	Oct. 5-May 25	spring	—
6. 20 min.	Oct. 5-May 25	spring	68±6
7. 30 min.	Oct. 5-May 25	spring	68±2
8. 45 min.	Oct. 5-May 25	spring	56±3
9. none	Dec. 5-May 5	spring	—
10. 20 min.	Dec. 5-May 25	spring	10±1
11. 30 min.	Dec. 5-May 25	spring	12±3
12. 45 min.	Dec. 5-May 25	spring	7±2

Much more is yet to be learned about American basswood seed germination. The potential is exciting — the unanticipated problems are frustrating. The net result of such endeavours will hopefully be a more consistent supply of American basswood seedlings and trees.

LITERATURE CITED

1. Barton, L.V. 1934. Dormancy in *Tilia* seeds. *Contrib. Boyce Thompson Inst.* 6:69-89.
2. Cumming, W.A., J.W. Morrison, and A. Vitins. 1964. Propagation studies in fruits and ornamentals at Morden Experimental Farm. Contrib. #49 from the Experimental Farm, Research Branch, Canada Department of Agriculture, Morden, Manitoba.
3. Cobb, F.E. 1932. Growing trees from seeds. *North and South Dakota Hort.* 4:127-128.
4. Heit, C.E. 1977. Propagation from seed, Part 27, *Amer. Nurseryman* 145(7):10-11, 100-110.
5. Schopmeyer, C.S. 1974. Seeds of Woody Plants in the United States. Agriculture Handbook #450. Forest Service, U.S. Department of Agriculture, Washington, D.C.

RALPH SHUGERT: Do you feel that there are differences in seed germination with seeds taken from different trees?

DAVID VANSTONE: Yes. We used 2 seed sources in the

experiments. Although both showed similar results, one source was better than the other.

EDITOR'S NOTE: Jack Alexander, Arnold Arboretum, showed a film: *Plant Propagation – A Tribute to Alfred Fordham*. The film is available from McMillan Films, MacQuesten Parkway, Mount Vernon, N.Y.

Friday Morning, December 1, 1978

Dr. Harrison Flint served as moderator of the morning session with Mr. Alfred Fordham serving as moderator for the New Plant Forum.

PROPAGATION OF MAGNOLIAS BY SOFTWOOD CUTTINGS

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Magnolias can be propagated from soft, succulent shoots and from semihardened cuttings providing rigid sanitation procedures are followed. We have used the method described below on a small scale at our park. The outdoor propagating frames are constructed in a shady area and covered with sash. We do not use mist in the outdoor beds; however, one could use mist in a greenhouse. Sand and sand-peat mixtures are satisfactory rooting media. Following bed preparation, I apply a Benlate drench at the rate of 1 teaspoon per gallon of water.

Cuttings should be 3 to 6 inches long with the soft terminal bud removed and the leaves cut in half. The cuttings should be wounded on one side. I have observed that when magnolias are wounded, many roots will be initiated along the side opposite the wound.

Before sticking, the cuttings are dipped in Hormodin 3, containing Benlate. The cuttings should then be stuck 2 inches deep. A groove is made in the medium before sticking, so as not to brush the hormone off. After sticking, the cuttings are well watered, and covered with sash and lath. The cutting bed should be kept well watered for the first 2 weeks. A weekly