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Scarification

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Scarification is the process of making hard seed permeable to water. Scarification abrades or scratches the impermeable outer coating of the seed. The objective is to facilitate the absorption of water and hasten germination. "Seed which remain hard at the end of the prescribed test because they do not absorb water due to an impermeable seed coat, are to be counted as hard seed."[1] "Hardness of seed coat is one type of dormancy. It is often responsible for volunteer stands of clover or the delayed germination of seeds that have lain dormant in the ground for years."[2]

To remedy this all crops with hard seeds are scarified or rendered some sort of treatment to increase permeability.

There are many known seed treatments to increase permeability. Physical treatments include scarifying, impacting, puncturing the outer layers with a pin, and clipping the ends of the seeds with a knife. Temperature treatments include exposure of the seed to alternate freezing and thawing; exposure to extremely low temperature, such as liquid air; and brief exposure to dry heat, steam or hot water. Chemical treatments generally are confined to the use of sulfuric acid. Of pressure treatments only those employing extremely high pressures, about 2000 atmospheres, have proven effective.

These processes are not always distinct or separable. Impacting and sulfuric acid treatments are unsatisfactory unless the seeds are hulled. Scarifying with a machine called a scarifier is the only process extensively or commercially practiced. Most scarifiers hull and scarify seed in one operation. High-speed hullers and scarifiers impact the seed and even heat it to some extent. On the other hand, mechanical impacting of hulled seed results in some abrasion of the seed coat. Hullers have some scarifying effect on seed; and scarifiers must either remove the hull or penetrate through it to contact the seed. Clover hullers, which were used for thrashing clover seed before the advent of the combine, were effective scarifiers as well as hullers. In the harvesting of sericea with a combine, it is to be expected that a large percentage of the seed will be hulled although it is impracticable, as a rule, to hull the seed in the field.

Although there are many ways to make the seed coat permeable to water, the most widely used and accepted ways to scarify seed is by the use of machines, acid (sulfuric), and impaction.

The advantage of scarification is that it makes for germination at approximately the same time, otherwise the seed will not germinate at the same time and uneven maturity of the crop will result.

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[1] H. A. Arnold, "Seed Scarifiers", Tennessee Agricultural Experiment Bulletin No. 194, page 3, 1945.

[2] Ibid.

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The disadvantages of scarification vary with the means of scarification used. The impaction method is lengthy and not all of the seed receive the same degree of impact. Mechanical scarification is a frequent cause of seed breakage. "Mechanical breakage of seed may occur during the harvesting, thrashing, handling, and processing operations such as scarification....."[3]

Mechanical injury to seeds may interfere with normal seedling development or it may completely prevent development, depending on the extent and place on the embryonic plant where injury occurs.

Chemical scarification doesn't seem to affect the development of the seedling one way or the other.

The four most common mechanical seed scarifiers are: hammer mill, sandpaper-abrasive, pneumatic-grater, and abrasive-disk.

The hammer mill either injured the seed excessively or was ineffective as a scarifier, although, at reduced speeds good hulling was secured without injury to the seed.

Sandpaper-abrasive gradually wore smooth which resulted in the hulling and germination percentages varying. Constant renewal of the sandpaper to secure uniform results is impracticable.

The pneumatic-grater machine was effective both as a scarifier and huller when run at 900 revolutions per minute and adjusted as recommended by the manufacturer.

The abrasive-disk type scarifier effectively hulls and scarifies seed and separates the seed from the chaff in one run. This type of scarifier produces light spots on the ends of oblong seeds. The extent of the light spots, as well as the amount of green dust discharged by the cleaner and settlings around the chaff, indicate the approximate degree of scarification. Sweet clover, lespedeza bicolor, sericea lespedeza, and button clover were successfully scarified and annual lespedeza was hulled without injurious effect to germination and field tests.

These hard seed that need scarification are found in four families: Leguminosae, the legume family; Malvaceae, the cotton family, Convovulaceae, the morning glory family; and Liliaceae, the lily family.

"Impermeable seed coats may occur in cotton and okra but scarification treatment to overcome this type of dormancy are not accepted as routine methods of seed testing."[4]

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[3]Agricultural Yearbook No. 30, Testing Agricultural and Vegetable Seeds, 1952, page 164.

[4]Ibid.

Delinting tends to have a scarifying effect on cotton. But the occurrence of hard seed is so small that they are of minor importance and isn't considered a problem.

But the Leguminosae (Pulse family) family offers the largest amount of hard seeds, therefore, this group is the only one with which we are concerned when scarifying; and the clovers are the only ones in this family that require scarification to any extent.

Some of the most common crops that require scarification are: white, red, crimson, button, bur, and sweet clover; Korean, Kobe, Common, sericea, and bicolor lespedeza; alfalfa; kudzu; and birdsfoot trefoil.

Sericea is an outstanding example of how important scarification is to germination. "The normal seed carry a high percentage of hard seed. Unless scarified the seed usually will not exceed twenty-five percent germination."[5] The following chart shows the effectiveness of scarification on germination

Effects of Scarification on Germination*

Crops	Unscarified	Scarified
Sweet clover	13	93
Lespedeza, bicolor	5	89
Button clover	26	75
Kobe lespedeza	89	97
Korean lespedeza	55	92
Sericea lespedeza	20	91

* H. A. Arnold, "Seed Scarifiers", Tenn. Agricultural Experiment Station, Bulletin 194, pages 1-23, 1945.

The effect of scarification is not always beneficial to germination. Scarification may cause abnormal seedlings to develop but the increase in germination compensates for the development of a few abnormal seedlings (due to excessive scarification and breakage).

Scarification also affects the durability of seed. In general, scarified seed deteriorate more readily in storage than unscarified seed. Scarified seed do not remain viable as long as untreated seeds. To illustrate this the New Jersey Agricultural Experiment Station in 1948 ran an experiment on the effect of scarification on longevity of alfalfa seed. This test ran over a period of 13 years. Four samples of Grimm alfalfa were used; three of these had been scarified and there was one unscarified (the check sample). One sample was scarified with sulfuric acid, another with sandpaper, and the other by exposure to dry heat at 60-degrees Centigrade for

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[5] H. D. Hughes, M. E. Heath, D. S. Metcalfe; Forages; page 204.

two hours. Then the seed were sealed in paper envelopes, placed in a cardboard box and stored in a drawer in an unheated building.

All the lots were clean and free of insect injury. The check seed and the heat-treated seed were plump and only slightly faded. The mechanically scarified seed (sandpaper) were also plump but had turned dark brown. The acid-treated seed was badly shriveled and deep-brown in color.

Ten lots of 100 seed each were weighed out from each sample. There was no significant difference in weight between samples except in the case of the acid-treated seed which were considerably lighter.

The following chart shows the variation between the samples.

Effect of Method of Scarification on Weight, Germination, and Incidence of Hard Seed in Grimm Alfalfa after 13 years.*

Treatment	Wt. of 100 seeds, mgm	Germination: %	No. hard seed in 500
Sulfuric acid	186.8**	0.0	1
Sandpaper	192.4	0.8	0
Dry heat	193.1	17.2	0
Check	196.8	23.0	5

* W. R. Battle, "Effect of Scarification on Longevity of Alfalfa Seed", American Society of Agronomy, 40:758, Aug. 1948.
** Difference significant at 1% level

Five lots of 100 seed were tested for germination and incidence of hard seed from each sample. No seed in the acid-treated sample germinated. Seventeen and two-tenths percent (17.2%) of the seed in the dry heat treated sample germinated and 23% germinated in the check sample. Five hard seed were found in the check sample and one in the acid-treated sample, none in the other samples.

There was no record of germination and percent hard seed at the time these four samples were drawn up 13 years ago. "Since these samples were originally drawn from a single seed lot, it is safe to assume, however, that heat scarified seed resulted in less injury to the keeping qualities of alfalfa seed than did mechanical or sulfuric acid scarification. There is no indication that heat scarification produced the desirable reduction in incidence of hard seed."[6] Although it is not common practice to scarify the

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[6] W. R. Battle, "Effect of Scarification on Longevity of Alfalfa Seed", American Society of Agronomy, 40:758, Aug. 1948.

seed and then store them, this experiment shows what effect scarification has on the germinating characteristics of the seed.

Scarification can be harmful as well as beneficial. The maximum degree of success can be obtained only when the seed have been properly scarified. Seed can be overscarified or not scarified enough. To avoid this the operator should be experience or have a working knowledge of the scarifier and the seed being scarified. If a commercial scarifier is being used the manufacturer's directions should be followed to obtain maximum effeciency, and if using a home-made scarifier the operator should be familiar with the process of scarification.

A scarifier that will meet all normal requirements can be constructed easily and economically. The Tennessee Agricultural Experiment Station in 1945 published a bulletin on seed scarifiers. This bulletin contains in detail plans to construct a 12 inch abrasive-disk scarifier. This machine would be ideal for the farmer and seed plants that do not scarify over 1000 bushels, or in that general area.

Summary

1. Scarification is the process of making hard seed permeable to water.
2. Most widely used ways to scarify seed are mechanical, chemical, and impaction.
3. The reason for scarification is to make for germination at the proper time.
4. Hard seed occur in the Leguminosae, Malvaceae, Convolaceae, and Lilaceae families.
5. Scarified seed do not remain viable as long as unscarified seed.
6. The full benefits of scarification are not realized unless the seed are scarified properly.

Bibliography

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2. H. D. Hughes, M. E. Heath, D. C. Metcalfe; Forages, pages 200 and 204.

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4. H. J. Hodges, "Effect of Heat and Acid Scarification on Germination of Seed of Bahia Grass, Paspalum notatum", Agronomy Journal 41, page 531-533, Nov. 1949.

5. W. R. Battle, "Effect of Scarification on Longevity of Alfalfa Seed", American Society of Agronomy Journal, 40:758, Aug. 1948

6. P. Tabor, "Moderate and Complete Scarification of Kudzu and Perennial Lespedeza Seed"

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8. P. T. Blood, G. M. Dunn; "Efficient Scarifiers for Small Lots of Legume Seeds", Agronomy Journal 45:576, Nov. 1953.

9. L. A. Tatum, "Seed Permeability and Cold Test Reaction in Zea mays", Agronomy Journal 46:8-10, Jan. 1954.