

Hard Seeds in Beans

proper temperature and humidity during storage important for germination

James F. Harrington

Hard seeds have seed coats which retard the entrance of moisture into the seed. Seeds with hard coats are slow to swell. Since water is necessary for germination seeds do not germinate so long as they remain hard.

Most hard seeds are alive and will eventually swell and germinate even though it may be more than a year after planting.

There are several reasons why seeds that are alive will not germinate in moist soil, but the term *hard seed* is reserved for those seeds which do not swell because of a seed coat that is impermeable to moisture. Considerable difficulty with hard seeds is encountered sometimes with White Seeded Kentucky Wonder beans planted for a market crop in California.

Possible Cause

Hard seeds have been found in all commercial kinds of legumes except peanuts and in seeds of a few other crops such as asparagus and okra.

In all kinds of beans and in most other legumes scratching the seed coat so moisture can enter the seed eliminates hard seed and allows rapid germination. The scratching need not pierce the seed coat. If an area of the waxy cuticle on the surface of the seed and the top of the outermost layer of cells is cut the formerly hard seed will germinate readily. It does not make any difference what place on the seed is scratched or scraped.

It seems clear that something in the seed coat controls the entrance of moisture and therefore germination. It has been suggested that there is a colloidal layer or deposit in the seed coat. It absorbs moisture readily when slightly

damp but when dry it is a film impermeable to water and only slowly becomes damp again. The drier the seed, the more slowly the film absorbs moisture.

Humidity Affects Hard Seed

If the idea of the colloidal layer in legume seeds is correct, then it is easy to see how dried seeds would be hard seeds and yet live seeds of the proper moisture content would germinate readily.

Research workers have found that the percentage of hard seed in several kinds of legumes is directly related to the moisture content of the seed. For example: one-pound samples of White Seeded Kentucky Wonder beans stored at Davis at 70° F and at different relative humidities had these percentages of hard seed:

Treatment	Moisture in Seed	% Hard Seed
Condition of seed at start of experiment	8.3%	33.5%
Relative humidity		
10% for 15 days	7.0%	67.5%
10% for 60 days	6.4%	74.4%
65% for 15 days	11.3%	5.2%
65% for 60 days	12.6%	0.0%

The above data show that a seed lot which is too dry has a large percentage of hard seeds. The data also show how quickly seed can change moisture content with changes in the relative humidity of the air.

At 60% relative humidity the moisture content in the seed lot rose to 12.6% in 60 days at which point there were no hard seeds. At 10% relative humidity the moisture content dropped to 6.4% in 60 days with 74.4% hard seeds.

In a continuation of this experiment it was found that the changes in moisture content were reversible.

Similar data have been obtained by other research workers with several varieties of bush and pole snap beans, Henderson Bush lima beans, vetch, field beans and soybeans.

This relationship between moisture content and hard seed percentage explains why seed of the same variety from different growing areas may have different percentages of hard seed, and why the hard seed percentage varies among harvests of different years. Moreover, the percentage of hard seeds fluctuates while the seed is in storage because the humidity and temperature in the storage change.

A seedsman who thinks he has a seed lot with few hard seeds may receive a report from a seed testing laboratory that the lot is high in hard seed content, because the seeds lost moisture in transit or in a hot, dry laboratory before the germination test was started. A seedsman sending seed into an arid region could be berated for selling seed with a hard seed content by a grower who stored it a few weeks, thus allowing it to dry so much that hard seeds developed before planting.

Breeding Is Important

Moisture content is not the whole story because seeds of different varieties, but of the same moisture content, may have different percentages of hard seeds. There is the genetic tendency toward hard seed that must be considered.

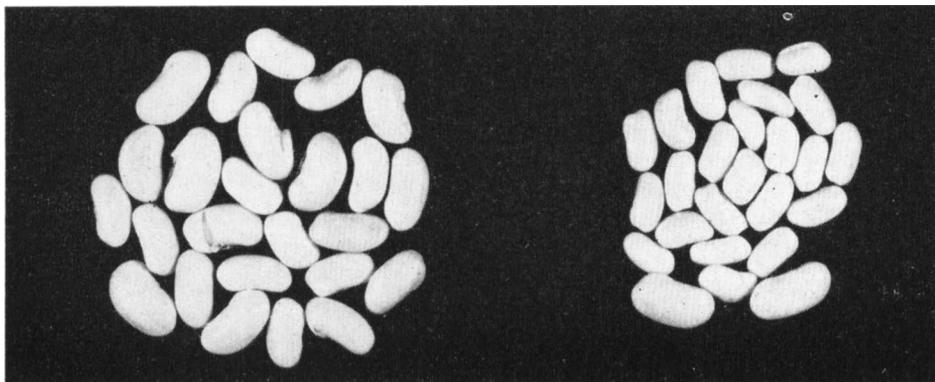
Plant breeders have shown that selections can be made and that by breeding, varieties or strains can be developed that show no hard seeds until very low moisture contents—below those in normal storages—are attained.

The present snap bean breeding program of the United States Department of Agriculture includes elimination of all breeding lines which show any hard seed under normal storage conditions. At least one seed company and probably others are following a similar program in their bean breeding work.

Elimination of Hard Seeds

A frequently used practice with legume field seeds to eliminate hard seeds is scarification—some method of scratching through the outer part of the seed coat.

Continued on page 12



White Seeded Kentucky Wonder bean seeds stored for three months at 70° F at different humidities. The 25 seeds on the left were stored at 65% relative humidity and then after 36 hours under proper germinating conditions all have swollen with no hard seeds. The 25 seeds on the right were stored at 10% relative humidity and after 36 hours under the same germinating conditions only two seeds have swollen with 23 hard seeds remaining.

OLIVES

Continued from page 10

With the importation in 1947 and 1948 of about 20 new varieties from France, Italy, Greece, Turkey, Palestine, Egypt, Algeria and Australia, this is now probably one of the most complete collections of table olive varieties in the world.

In connection with this work on varieties, a study has been made of the tree and fruit characteristics of all the available bearing olive varieties in California.

Rootstocks

To supply some information as to the value of own-rooted olive trees in comparison with grafted trees, a rootstock planting will be set out next spring at the Wolkskill Experimental Orchard. A planting of 10 acres will be made with about five acres used for the rootstock tests. Trees will be grown on a number of different rootstocks, including several different *Olea* species, for comparison with the trees started from cuttings.

In preparing trees for this proposed olive planting, tests were made with various hormone root-forming substances to determine their value in rooting softwood olive cuttings.

It was found that indole-butyric acid at about 50 parts per million gave very good results in inducing root formation.

Last spring a similar test was made using hardwood olive cuttings. The results of this test will be known at the end of the current growing season.

Fruit Measurement

During the 1946-47 and 1947-48 seasons, growth studies were made of developing olive fruits. Measurements of fruit size—volume, diameter, fresh weight, and dry weight—moisture content, and oil content were taken. Two years' results have been obtained using the Mission and Manzanillo varieties and a complete report of this work will be published soon.

Pruning

Two pruning plots have been established—one in Tehama County and one in Butte County—to give information on how severely bearing olives should be pruned.

Two years' results, while insufficient for drawing conclusions, have been in agreement that the trees receiving the least pruning have been the most profitable.

Fertilization

To determine whether the time at which nitrogen fertilizers are applied to olives has any effect on fruit set, experimental

plots have been established in Tehama and Tulare counties in which different trees are fertilized at about two-month intervals throughout the year. Results must be obtained for several years before valid conclusions can be drawn.

Nontillage

Another phase of current olive research concerns the practice of nontillage in olive orchards—the control of weeds by oil sprays. A number of experimental plots have been set up by the Agricultural Extension Service in the several olive producing counties to examine the feasibility of such practices.

An experimental plot also has been established by the University in Glenn County where trees are grown under clean cultivation, sod culture, and weed control by oil sprays.

Individual tree-yield records were obtained for the 1947-48 season. The maintenance of such plots for a number of years will compare the value of these different types of soil management.

Specialized Studies

A number of other projects are underway, such as nutrition studies, including minor elements, physiological effects of spray materials, collections of desirable variety strains, blossom-thinning sprays, fruit-bud differentiation, irrigation studies and temperature in relation to fruitfulness.

Many of these projects must be carried on for a number of years before definite results can be expected.

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GRUBS

Continued from page 5

rotenone-sulfur formula seems superior.

Recent work conducted at the University of California has demonstrated that the northern grub is more resistant to treatment than is the common grub; however, control of either species is often incomplete.

The main value of the present program of area-wide treatment lies in the fact that a single season of community-wide spray treatment in a grubby area will reduce the number of grubs so much that relatively little trouble will be experienced the following year.

There is the immediate advantage of ridding the animals of those grubs currently sapping the vitality and reducing the market value of the stock.

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SEEDS

Continued from page 4

Scarification may frequently be harmful, especially with beans because growing points of some seeds are injured by the rough treatment. If not carefully done, too much coat is scratched off causing a rapid decline in viability, and allowing a ready entrance for fungi.

Another practice is to keep the beans and possibly other legumes in a storage of the proper humidity and temperature so that the moisture in the seeds is maintained high enough so there are few or no hard seeds, yet the moisture is not so high as to cause loss of viability.

From the experimental results obtained at Davis, and from the work reported by research workers in Connecticut and in Puerto Rico it seems that at storage temperatures around 70° F, a relative humidity of 50% or a little higher is dry enough to prevent all but a few hard seeds in even the most susceptible varieties.

For long storages of over a year, a lower humidity or a lower temperature is advisable. The seed could then be stored at the higher humidity or temperature for a month or six weeks before expected shipment.

The long time approach is to make selections or breed out of each variety the tendency for hard seed development at normal storage humidities.

Thus, if bean seeds are stored in the proper humidities, hard seeds can be reduced greatly or avoided. If the seed companies and experimental stations test for hard seeds in their breeding and selection programs the strains with genetic tendencies toward hard seeds may be eliminated.

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FIRE

Continued from page 3

is important also to consider cost and difficulty of replacement as well as use and occupancy in the case of destruction by fire of homes, farm buildings, fences and other improvements.

Increased costs for materials and wages and marked scarcity of many critical items may make quick replacement of burned facilities virtually impossible without undue delay.

A farm home, barn, milk house or other equipment may be quite as vital in the carrying on of farm operations to the owner as is a factory, mill or office building to a business corporation. The hidden losses must include the cost of replacement and the inconvenience of doing without such destroyed facilities.

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