A Method For Testing The Germinability of Large Seeds

By M. T. Munn

A test roll of seed corn weakened by freezing reveals the tell-tale defects

NEW YORK STATE AGRICULTURAL EXPERIMENT STATION
GENEVA, N. Y.

BULLETIN NO. 740 • APRIL, 1950
THE slant or upright method for germination testing of large-sized seeds is described. The seeds are placed in rolls of moist paper which are in turn supported by trays or baskets in a slightly inclined upright position in a germinator. The rolls may be fortified with parchment paper if desired.

The method has the advantage of normal geotropism during germination and the stem and root growth of the seedlings from any stock may be readily appraised as to vitality and freedom from seed-borne disease organisms. It also enables one to detect any abnormal condition, as well as to ascertain the percentage of normal germination. The test rolls in this upright position can be copiously watered which is an advantage.

The seeds, disinfested when necessary, are equispaced upon the moistened paper by means of a transparent counting board and then the whole carefully lifted or rolled into rolls which permit unhampered development of the seedlings yet offer sufficient resistance to reveal any weaknesses. With moisture, time, and temperature under control an experienced analyst can appraise seed stocks very close to expected field planting value.

The kinds of seeds best germinated by this method are all the large-sized agricultural seeds, such as beans, corn, cotton, peas, peanuts, soybeans, velvet beans, vetch, some large tree seeds, and certain flower seeds, including castor bean, nasturtium, and sweet peas. The method can be adapted with advantage to the germination testing of some legume and grass seeds in special cases where seed injury of a mechanical nature has taken place and normal cotyledon or root development is in question since it simulates natural or field conditions quite closely.
A METHOD FOR TESTING THE GERMINABILITY OF LARGE SEEDS

M. T. MUNN

Successful germination testing of seeds depends upon placing the seeds under favorable conditions and in such a position as will permit each seed to reveal its true ability to produce a normal seedling.

In 1921,\(^1\) and again in 1943,\(^2\) the writer presented the results of investigations designed to make worthwhile germination tests of such character and under such conditions as to give the greatest practical value. A method was devised to reveal seed vitality as shown by normal stem and root growth, color and condition of the growth, and bacterial and fungous development, and to enable one to detect any detrimental abnormal condition of the seed due to unfavorable harvest or storage conditions and possible harmful effects or poisoning due to incorrect chemical or other seed treatments. (See Fig. 1.)

The conventional methods in use for most large-sized seeds are boxes of soil, sand, sawdust, or other materials, greenhouse benches, folded pads of paper and cloth, and, more recently, rolls of paper layed on trays in a horizontal position. All of these methods have more or less objectionable features in that temperature and moisture are not always under control, root and stem growths are entangled obscuring weaknesses, bacterial and fungous development are enhanced, and perhaps most serious of all, seed-borne diseases are obscured or masked out.

The method described in this bulletin consists essentially of placing the paper rolls containing the counted and evenly spaced seeds in an upright or slightly inclined position, preferably facing the light. By this means advantage is taken of positive and negative geotropism to reveal normal growth extension or response. Also, the germinants can be copiously watered, the excess water running away and carrying


Fig. 1.—A test roll of corn (left) and peas (right), showing the ease and certainty with which it is possible to detect normal seed strength, both primary and secondary root growth, freedom from disease organisms, and percentage of germination when large seeds are germinated in upright-position, paper-test rolls.

with it certain food solutes which tend to harbor bacteria and fungi so often annoying and destructive to the ordinary test roll when lying horizontal in a closed germinator.

The original germination apparatus is shown in Fig. 2 which illustrates the types of test-roll trays used and the trays of rolls in a slightly inclined position in a larger wire basket in a germinator which has ample drainage facilities in the bottom with automatic heat control with a Lolag or other type immersion heater in the 3-inch depth of water below the rolls.

The large removable wire frames or baskets to hold the smaller trays of rolls are the same size as the standard germinator tray, about 18 × 20 inches, 9 inches deep, and have at least four stiff cross wires or braces to support the trays of rolls standing on end in a slightly inclined position. The trays or racks to hold the test rolls are minus a top and one end. They are about 2 inches deep, 11 inches high, and either 4, 8, or 16 inches wide to accommodate 2, 4, 8, or 10 rolls as desired. One can use individual baskets of any size. The roll trays are stood against the supporting crosswires of the larger baskets or frames
with the closed end down and at an angle of about 20° to 30° from the perpendicular.

The larger wire baskets and the roll trays can be made of stiff hardware cloth of about \( \frac{1}{2} \)-inch mesh, of close mesh muskrat fence, or even of perforated sheet stainless steel or aluminum. Smooth metal trays are easier to handle and to keep clean and do not catch on the basket container so readily when removed. Various types and sizes of equipment, utilizing the essential principle of the method have been devised and adapted in a number of seed testing laboratories since the procedure was first introduced in 1943. Some have even placed baskets in standard germinators.

The rolls are made up by using at least two sheets of seed germinating paper, 10 \( \times \) 15 inches, as sold by seed testing supply houses. Paper toweling can also be used. The paper is thoroughly moistened to full water-holding capacity since large seeds require considerable initial moisture.

The seeds are equispaced on the paper by means of a counting board or guides having 100 holes. The best counting boards are made of clear Lucite or Plexiglas \( \frac{1}{4} \)-inch thick and of a size to nearly cover the size of the germinating paper or towel. The 100 holes are bored through the material by boring from each side to

---

**Fig. 2.**—Experimental germinator with glass top-opening doors, near a window, used to accommodate test rolls in an upright position. Section on the left shows a full length test-roll tray with 10 rolls, and a smaller individual tray or basket which may be used. The test-roll trays when filled with rolls are lowered into the large frame or basket shown in the opened section on the right which will accommodate 25 samples. The test rolls can be copiously watered from the top since the water passes down through the rolls and around the seeds into the overflow tank in the bottom which also contains the temperature control, heater, and cold water when needed.
prevent cracking of the edges of the holes. The holes can be reamed out smooth if desired. The holes should be about 1 inch from the border of the paper. A 12/16-inch hole, in a pattern of $9 \times 11$ holes plus 1 at the top, with 1 inch to centers, will prove excellent for beans and large seeds. Boards with $\frac{1}{2}$-inch holes for peas can also be easily made.

Time-control tests showed that in actual practice the single, quickly removable counting board working from the top of an arranged pile of moistened papers was definitely easier and more rapid than counting boards with hinges, slides, or other devices. Furthermore, after the seeds were placed in the holes a quick, short shifting back and forth lengthwise of the board on the paper served to line up bean and corn seeds crosswise of the rolls in a desirable pattern for perfect rolling.

Experience showed that fastest placing or "planting" of the seeds came when one grasped a handful of the sample with the left hand and with the right hand took several seeds from the left hand and filled the holes from left to right and from top to bottom. For large seeds, such as lima beans, the number of seeds will necessarily be reduced to 50. This would also be desirable if the sample showed any untoward or soiled appearance.

Rolling up the roll properly, really folding it over, is most important. The art of rolling is more important than the science involved. Rolls must not be rolled too tightly else there will be considerable bursting of the paper as germination progresses. Have the first row of seeds about 2 inches in from the bottom, then with the index finger and thumb of each hand at the corners of the papers lift up and fold over the paper up to and covering the first row of seeds, and then press or form it lightly in place. Continue for about five folds until the roll is complete, with the final or top end under the roll. A little practice will enable one to fold a flat or ovate roll that will provide plenty of room for expansion when germination starts. Practice a few rolls over a ruler to get the best pattern.

Parchment paper or waxed paper dividers can be used if desired for some kinds of seeds. Experience over several seasons showed that the $10 \times 14$ inch parchment paper sold by dairy supply houses was very useful when used in rolls of beans and corn. If used, carefully place one sheet on the top of the seeds after they have been planted and just before rolling so that the parchment is rolled in place, thus making a stiffer roll and allowing water to pass down
more readily. It also serves to isolate any focus of disease from any one seed. With peas and some other kinds of seeds the parchment or dividing paper proved of no advantage. In unrolling the finished test roll the parchment or wax paper does have value since one can use it as an aid to peel back or unroll the roll by holding down the roll with the other hand, thus exposing the entire completed test in one movement. A third germination paper layed over the top of the seeds will accomplish the same purpose.

**Pretreatment** is plainly indicated in some lots of seed by the color and fouled condition of the stock. To place such seeds under highly favorable, artificial germination conditions causes profuse bacterial and fungous growth which may obscure the real worth of the seeds. Also, in all such cases, the number of seeds planted per roll should be reduced to 50. In such cases even a quick washing of large seeds with water is advantageous. Better still is the use of one of the liquid disinfectant dips upon the counted seeds. Also, they may be dusted in a closed container with one of the fungicidal dusts, removing the excess by means of a sieve or small wire strainer before placing in the rolls. A dust such as Arasan plus equal parts of wheat flour makes an excellent disinfectant for many seeds. Other dusts may be as easy to handle and as effective.

**Number, identify, and date** the rolls as desired with an indelible pencil or a coloring pencil.

**The completed and numbered rolls** can be handled rather safely without displacement of the seeds if the paper has been sufficiently moistened and if reasonable care is exercised in placing them in the roll trays. It is not necessary to use rubber bands around the rolls if one learns the art of rolling and handling. If bands are used on rolls stood completely upright, they should permit of sufficient expansion of the enlarging roll. It is not desirable to press either the top or the bottom of the roll together tightly since it may prevent passage of the water or cause water-logged spots.

**Watering or moistening** of the test rolls is easily accomplished when the baskets or frames holding the roll trays are supported over a water-tight tank or container with overflow. During the first experimental work sprinkling was employed. Later this gave way to the use of a ½-inch hose attached to the water line, and carrying a 2-foot length of light copper tubing with a right-angle elbow and short nipple at the end to direct the water gently down into the ends
of the test rolls. This tube also served to pull open the top of any rolls partially closed by handling.

The tightness of the germinator and the temperature employed determine the amount of watering necessary. If twice a day, it will be found advantageous, though not necessary, to use water of about the temperature of the alternating change, whether 20° or 30° C. When the slant rolls are copiously watered from above, one cannot overwater since any excess passes out through the bottom of the rolls. In fact this system of watering adds to the success of the method since much of the annoying decomposition or growth by-products is washed away. When rolls enclosed with waxed or parchment paper and secured with rubber bands are placed in a germinator where they cannot be watered sufficiently from above, one needs to guard against dry centers in the rolls or, on the other hand, wet, soggy, bacterial pockets.

Reading the results of the tests is done on the last day of the expected duration period for the kind of seed under test. The rolls are left undisturbed during the entire period unless daily observations made at the time of watering indicate that the rolls are showing unusual decay or fungous growth in which case the test rolls, or the roll tray, are lifted out and the aberrant or decaying rolls appraised, removed, or overhauled. When the trays and rolls are removed from the germinator, close attention is given to the amount and degree of root growth as well as that of the stems and leaves. It is rather easy to detect a weak vitality stock as compared with a normal stock when judgment is based upon familiarity with normal stocks on a heat-unit-time basis. (See Figs. 3 and 4.)

When lifting the test roll from the
tray for reading, give it a slight twist which serves to free the stems and roots from the paper. Then if a third paper or parchment is used on top of the planted seeds, grasp that with one hand and while holding down the papers with the seedlings with the other, pull back the covering paper revealing the final results. This will enable one to detect the development of any seed-borne disease organisms, weak seedlings, deformity or abnormal growth due to seed treatment poisoning, general growth strength or vitality, and the percentage of normal seedlings.

The great advantage of the method is that the results can be easily appraised in all aspects since no part is obscured in sand, soil, or other masking material. Also, the germinating seedlings are not badly entangled as is the case with the usual conventional methods. Another advantage of the method is that with beans and soybeans as the developing seedlings erect themselves toward the light be-
Fig. 5.—A series of test rolls of garden beans, showing the manner in which the moist seedcoats are brushel or pulled off thus exposing the cotyledons and plumules. When unrolled all of the germinating seedlings lay out in more or less orderly fashion and can be easily examined for any abnormal conditions, and the percentage definitely determined.

tween the folds of paper, they pull or brush off the moist seedcoats, thus exposing any abnormal cotyledons or seedlings without plu-
mule due to excess seed injury. (See Fig. 5.)

Seeds of beans, peas, corn, cotton, cowpeas, field peas, peanuts, soybeans, velvet beans, other large seeds, large tree seeds, and some flower seeds such as castor bean, nasturtium, and sweetpeas, are easily tested by this method. It has also been increasingly used to test some lots of alfalfa, clover, and grass seed where growth development is under question (Fig. 6). Smaller paper rolls are made for tests of the smaller seeds and are supported in smaller baskets, such as test tube baskets, into which a sloping support is placed. Such units can be placed in the usual chamber germinator and otherwise are handled as the larger seeds.