writers gave the length of the roots as equal to the length of the branches above. It is safe to say that this rule does not indicate generally more than a tenth of the ground which the entire roots really occupy. Many years ago, I made an experiment on a row of peach trees planted in grass and within a few feet of each other. They had been set three or four years and were eight or nine feet high. Within a few feet of one end of the row, the ground was made very rich with a heap of manure. Its stimulating effect on the nearest tree was such that the shoots made in one season were two feet and a half long. The tree which stood seven feet from the manured ground made shoots fifteen inches long, and at eleven feet distance the shoots grew seven or eight inches. At fifteen feet, no perceptible effect of the manure was visible, the growth not exceeding three inches. The experiment showed that a decided benefit was gained to the tree at eleven feet distance, through the few roots on one side, and that the roots formed a radiating circle at least twenty-two feet in diameter. The absurdity of the practice of applying a small heap of manure at the base of the trunk of a tree, is obvious.

Some twenty years ago, I furnished a statement to the American Pomological Society, which was published in its volume of transactions at the time, giving the results of a series of examinations of the roots of dwarf pears, the fibres of which had been generally supposed to be short and in a dense mass. In additional examinations, I found no difficulty in tracing the roots of dwarf trees, which had been set three or four years, to a distance quite equal to the height of the trees, and those which stood five or six feet high, had circles of roots ten or twelve feet in diameter. Since then, Prof. Beal and his students have made more careful examination of the roots of orchard apple trees, and found such as were twelve or fourteen years old with roots twenty-six feet or more in length. The suckers which some shade trees have thrown up at a distance from the trunk greater than the entire height, furnish additional proof on this subject.

The erroneous practices which generally exist among farmers in consequence of a want of knowledge of the nature, extent and uses of the roots of the crops which they cultivate, undoubtedly result in aggregate losses throughout the country amounting to millions. The subject in all its bearings is worthy of careful and continued investigation. The right application of fertilizers for the best effect, is as important as applying food to the mouths of animals, instead of to their feet. If this association can devise a series of experiments for the thousands of thinking farmers to carry out in practice, and to guide them in their investigations, a most important benefit would be conferred on all, and material aid afforded in the progress of agricultural science and practice.

TESTING SEEDS.

BY W. J. BEAL.

The great importance of testing seeds, to ascertain their vitality, purity, identity and freedom from foreign substances has already been clearly demonstrated by the efforts of many persons. This is true of seeds which are home grown, and especially true of seeds which are obtained by purchase. In America, the subject can hardly yet be said to have been fairly started. People are just beginning to think of the subject, but

have done very little. Once decided that it is important to test seeds, the next step is, "How shall they be tested?" In making tests, the fact must not be lost sight of, that the finest looking seeds and those which show the greatest portion of living seeds may not be the most desirable for the field or garden. Much depends on the variety, the choicest strains of some kinds producing seeds of inferior appearance and vitality. One of the objects of the following experiments is to consider some of the points in regard to the best modes of finding the vitality of a few kinds of seeds.

In several countries of Europe, this part of the subject has commanded much attention, and as one of the results, several kinds of apparatus have been manufactured and put on the market. I have had the privilege of using but one kind of this apparatus. That one is, the plates for testing seeds manufactured by E. H. Krulage & Son, Haarlem, Holland. The plates are made of fine potter's clay, and are fifteen centimeters in diameter or nearly six inches. These plates are of two sorts, one containing twenty-four numbered pits or depressions; the other five larger depressions.

To get the highest per cent to germinate, we have concluded that particular modes of testing must be employed for the seeds of certain species, genera or families. In a number of cases where the seeds possessed a low vitality, it has been found by others that certain chemical substances increased the per cent which would germinate. I have not employed any of these.

To hit upon the best method in a certain case, as that of wheat, we need a quantity of seed which has been well grown, carefully harvested, and is known not to have been subjected to several trials or long exposure to great extremes of drought and moisture, heat and cold. This reliable seed wheat can be tested by some of the best known methods, and if found to be of prime vitality, it can be used side by side in the different methods employed for testing other lots whose history is unknown. In these modes attention must be given to all the details of moisture, air and temperature; the manner of selecting an even lot of seeds; the quantity of each to be used, and perhaps other matters which are not here mentioned. In German stations the kind of work done is chiefly the following:—Determination of the genuineness of genera or species; the total amount of impurities; the nature of the impurities and their respective amounts; the germinating power of seeds; the absolute weight of seeds; their specific gravity; their weight per bushel; detection of sophistications, such as dyeing, blacking, oiling, etc., (Transactions of the Highland Agricultural Society, page 288, 1878.) To aid in carrying on this work, they need collections of genuine seeds of the varieties known to be pure; they need seeds of weeds accurately identified, They need seives of various grades; bellows, delicate scales, thermometers, jars, test plates, chemical tests and other apparatus. The stations for testing seeds in Europe are kept up by enterprising farmers aided by the government.

In the spring of 1881, I procured from a mill in Lansing some white wheat of good quality. Nothing was known of its age or history. On May 19th, ten lots of one hundred kernels each were tested as follows: All the kernels which had a suspicious look were rejected. The temperature of the botanical laboratory where they were tested ranged from sixty to eighty degrees Fahrenheit. Small glazed saucers were one-third full of wet sand. The dry wheat was placed on the sand which was covered with wet thick carpet paper—soaking wet. Over all was a board with a little chance for air. A little water was added as the seeds seemed to need it. After a time the papers moulded some

and the roots of the wheat penetrated the papers. The dryest looking lots did the best. After six days the result showed that out of ten lots of one hundred each the following numbers had sprouted, 81, 82, 84, 85, 85, 87, 89, 89, 90, 96, an average of 86.8 per cent. On May 23d, in the same room with the same apparatus in a similar manner, the same quantity and the same lot of seeds were tested with the following result, 56, 75, 75, 76, 77, 78, 78, 79, 82, 89, averaging 76.5 per cent. Here is a difference in the results of 10.3 per cent for which I cannot account. On July 23d, were tested some hand-picked red wheat of first rate quality. It was shelled by hand and not quite dry enough to grind well. In glazed dishes between wet folds of heavy carpet paper were placed five lots of one hundred kernels each. The paper was kept moist till August first when the seeds were counted with the following results, 100, 100, 100, 100, 100, an average of one hundred per cent in germination. On August 2d, wheat soaked 12 hours in water was placed in testing plates in the tropical room of the green-house as follows. The temperature ranged from about 80° to 100° Fahrenheit. In four days 116 and 116 out of two lots of 150 kernels of the Ingersoll wheat germinated, about 77 per cent; 150 and 150 kernels of fresh red college wheat germinated out of 150 and 150 kernels or 100 per cent. On August 2d, some dishes kept damp were placed in a vacant room in the green-house where in the day time the heat ran up to 130°–136° Fah. Out of two lots of 100 kernels each of Ingersoll wheat, 50 and 65 germinated, or 57.5 per cent, and 100 per cent of two lots of 100 kernels each of fresh college wheat germinated. On August 2d, wheat was tested in the botanical laboratory as follows. The temperatnre during the day, for a part of the time, was 94° to 98° Fah., and all the time very warm. Wheat was tested in covered porous saucers set in plates of water. Of three lots of Ingersoll wheat of 100, 100, 100 kernels, 36, 40 and 40 grains germinated, or nearly 39 per cent. Three lots of fresh college wheat of 100, 100, 100 kernels were treated in the same manner, and of these 100, 100, 99 germinated or 99.7 per cent. In another saucer were 150 kernels of Ingersoll wheat which gave 106 in germination, or about 71 per cent; and in another saucer were 150 kernels of fresh college wheat which gave 149 in germination or 99.5 per cent. The lots of Ingersoll wheat became very mouldy and sprouted much the soonest, as they were white wheat; while the college wheat was red. On August 2d, in very dry and hot weather, 1000 kernels of Ingersoll wheat, first two hours in water, were planted ½ inches deep in sandy soil in the garden. The bed was well watered twice and covered with boards. In three days it rained and became much cooler. In a few days these were examined, 66, 69, 76, 76, 71, 65, 76, 66, 77 and 73 had, germinated, averaging 71.8 per cent. At the same time and place, and in the same manner, 1000 kernels of fresh college wheat were sown in lots of 100 each and gave 95, 93, 98, 98, 96, 90, 94, 96, 95 and 94, averaging 94.9 per cent. This new red wheat was always slower in starting than the old white wheat. Some kernels were not found.

What are all these figures worth? Perhaps not very much, but we are quite safe in drawing some conclusions, while the experiments point to still other conclusions with some degree of probability. 1st. When tested in different manners or at different temperatures, or even side by side in the same manner at the same time, wheat with a low test or low vitality, varies much more in its germinating power than fresh wheat with good vitality. In other words, good seeds have the most endurance. They will stand the most abuse. 2d. White wheat germinates quicker than red wheat. Prof. W. W. Tracy and perhaps others, have found great var-

iation in the results, where they had tested many lots taken from the same packages of seeds of Cucurbitaceæ.

Some seeds of Turban squash tested in two different ways by Prof. Tracy, experimenter for D. M. Terry's Seed Company, were found to contain 50 per cent of living seeds. I tested some of the same lot in damp earth in the green-house, with a temperature of about 70 degrees, and 20 others were soaked 12 hours in water and then placed between folds of thick paper kept wet; 20 others in wet paper without being previously soaked in water. Of the first lot, 45 per cent germinated; of the second lot, 55 per cent; of the third lot, 35 per cent. On June 9th, 25 seeds of each of 4 lots of pumpkin seeds were placed on sand in dishes covered with thick wet paper at a temperature of 70 to 80 degrees. Home grown seeds of 1880, grown near Adrian, gave 100 per cent of living seeds, from Peter Henderson & Co. 72 per cent, Gashaw 44 per cent, College Garden 96 per cent. On June 8th, seeds of D. M. Ferry's pumpkins and squashes were purchased at a grocery in Lansing. A board frame was set in sandy soil in which were planted 250 pumpkin seeds and 200 seeds of Hubbard squash. Of the pumpkins, 180 or 72 per cent grew, of the squashes, 146 or 73 per cent grew. Of the same seeds, 100 pumpkins and 100 squash were planted in sand with a box having a glass cover. The experiment failed on account of the interference of mice. At the same time, 80 seeds of pumpkins and 80 seeds of squashes were planted in sand in the green-house, at a temperature of 60 to 80 degrees F. Of the pumpkins 36 or 46 per cent grew. Of the squashes 33 or 41 per cent grew. On June 17, after a heavy rain, with the thermometer at 80° Fahrenheit, I sowed in a sand bed in a garden, 200 seeds of the same lot of pumpkins, and 200 seeds of squashes. Of these pumpkins, 102 or 51 per cent grew; of the squashes, 107 or 63 per cent grew. Summary of testing this lot of seeds of Hubbard squash: 1st test in the garden 73 per cent, 2d test in the garden 53 per cent, in the green-house 41 per cent. Summary of testing the above lot of pumpkin seeds: In the garden, 1st test, 72 per cent, 2d test, 51 per cent. In the green-house 45 per cent.

We can hardly fail to draw the conclusion that some of the modes of testing were at fault, as the results of testing pumpkins and squashes run quite parallel. Some seeds were presented by D. M. Ferry and Company with a view of testing; among them seeds of Boston Marrow Squash and Marblehead squash. On July 23d, in hot weather, 200 seeds of Turban and 200 of Marblehead squash were planted in sandy soil in the garden, in the same place and manner and by the same person, who planted all the other seeds and those which are mentioned below. Of the Boston Marrow, 123 or 62 per cent germinated; of the Marbleheads, 100 or 50 per cent germinated. On July 30th, in a vacant room of the green-house, where during a part of the day the mercury arose to 115° to 136° F., were placed in test plates kept covered and damp 35 seeds of Boston Marrows and 15 seeds of Marblehead. Of these Boston Marrows 34 or 98 per cent sprouted, of the Marblehead 13 or 86 per cent sprouted. On August first, in the stove room, where plants were kept in damp air at 90° to 98° Fah., 100 seeds of Boston Marrow were placed in damp folds of thick woolen paper, enclosed in a wire box to keep away vermin; of these 95 per cent germinated. Summary of the above in regard to squash seed:

200 Turban in the garden, germinated 62 per cent.

35 Turban in a hot room of the green-house at 136° F., germinated 97 per cent.

100 Turban in a stove room of the green-house germinated 75 per cent.

200 seeds of Marblehead, in the garden, germinated 50 per cent.

15 seeds of Marblehead in the hot room of the green-house at 136° F., germinated 86 per cent.

On June 16th, weather quite cool, seeds of melons were placed in porous saucers, for two weeks, where only one side was kept moist. No seeds germinated. The seeds were then placed in dishes of moist sand and covered with moist carpet paper. In four days, 50 seeds of the Boss from J. H. Landreth were counted and showed that 86 per cent had germinated. The same amount of Harris Christina remained in the damp saucers three weeks without germinating. They were then placed in sand as those above and after 6 days 80 per cent germinated. Seeds of Peerless watermelons were sent me by D. M. Ferry & Co., with a view to testing. On July 15th, in the botanical laboratory, with an afternoon temperature ranging about 86° F., 360 seeds were placed in Krelage's test plates in lots of 25, 30 and 50 seeds. The plates were set in dinner plates containing a little water, and all were covered to prevent evaporation. A trifle over 98 per cent germinated. On the same day, in the same room, 900 seeds were placed in porous saucers and these set in plates of water. In some saucers the seeds were kept under water; in others, the seeds seemed to dry. Of all the 900, 96 per cent germinated. On July 22d, in the same room, 600 Peerless melon seeds were tested in porous saucers, and 600 in test plates. Of those in saucers, 95 per cent grew; of those in test plates, 95.5 per cent grew.

On July 30th, in the hot, vacant room of the green-house above referred to, when the thermometer ran up to 136° F., in the day time, 50 seeds of Peerless watermelon of the above lot gave 98 per cent of living seeds. In the hot stove room above mentioned, 200 seeds gave 98 per cent.

Summary of testing seeds of Peerless watermelon:

360 seeds in test plates at 86° F., germinated 98 per cent plus.

900 seeds in porous saucers at 86° F., germinated 96 per cent.

600 seeds in test plates germinated 95.5 per cent.

600 seeds in porous saucers germinated 95 per cent.

50 seeds in test plates, in the green-house at 136° F., germinated 98 per cent.

200 seeds in wet paper in the stove room, germinated 98 per cent.

Similar tests were made at the same time with seeds of the white spine cucumber:

200 seeds in the garden germinated 90 per cent.

100 seeds in the green house in plates at 136° F., germinated 99 per cent.

200 seeds in the stove room of the green-house, germinated 97.5 per cent.

By comparing all of these summaries in testing seeds of large squashes, pumpkins, melons and cucumbers, it will be seen that seeds of cucumbers and melons vary less when tested under different conditions than do seeds of pumpkins and squashes; that seeds of squashes and pumpkins show the highest per cent of growing seeds when subjected to a maximum heat of 100° to 136° Fahrenheit.

THE VASICULATING TEST FOR WHEAT FLOUR.

BY R. C. KEDZIE.

A test for the pannary quality of wheat flour, which is of easy application and uniform action is a widely felt want. The albuminoids of vegetable life, like these of animal life, are liable to minute changes which seriously affect their culinary value, the quality of the albuminoids being