U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—BULLETIN NO. 90, PART I.
B. T. GALLOWAY, *Chief of Bureau.*

THE STORAGE AND GERMINATION OF WILD RICE SEED.

BY

J. W. T. DUVEL,
ASSISTANT IN THE SEED LABORATORY.

ISSUED SEPTEMBER 7, 1905.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

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THE STORAGE AND GERMINATION OF WILD RICE SEED.[a]

INTRODUCTION.

The seed of wild rice, sometimes called Indian rice or water oats (*Zizania aquatica* L.), has always been a very valuable food among the Indians, especially those of the upper Mississippi Valley. Of recent years wild rice has found a place on the menu cards of some of our best American hotels. The rich and highly nutritious grains, together with the slightly smoky flavor it has when properly prepared, make it an extremely palatable article of diet. If it were not for the difficulties of harvesting the seed and preparing the finished product for market it is probable that wild rice would find a place in many American homes.

At present, however, the greatest interest in wild rice is created by the value of the seed as a food for wild waterfowl, particularly wild ducks. As a result of this interest the propagation of wild rice from seed has become a question of considerable importance, especially to the members of the gunning clubs throughout the United States and Canada.

DISTRIBUTION.

The distribution of wild rice is now reported from New Brunswick and Assiniboia south to Florida, Louisiana, and Texas. There are, however, comparatively few localities in which it grows abundantly.

[a] Wild rice is considered one of the most important foods for wild ducks and other waterfowl, and a large number of inquiries have been received from members of gunning clubs throughout the United States asking where good, germinable seed can be secured. It is quite generally recognized that wild rice seed loses its vitality if allowed to become dry, and better methods of storing the seed during the winter have long since been demanded.

The results of investigations begun two years ago show that wild rice seed can be handled without any deterioration in vitality if it is harvested and stored according to methods outlined in the present paper.

J. W. T. Duvel, *Acting Botanist in Charge of Seed Laboratory.*

Seed Laboratory,
Washington, D. C., July 20, 1905.

Good reasons exist for assuming that this area can be extended to include all fresh-water lakes, as well as swamps and river bogs, where the water does not become stagnant, throughout the whole of North America south of latitude 55° north. Wild rice also grows luxuriantly along the lower parts of many of the rivers of the Atlantic Coast States, the waters of which are affected by the action of the tide to a considerable degree, and consequently contain an appreciable quantity of salt. It has been shown[a] that the maximum degree of concentration of salt water in which wild rice plants can grow successfully is equivalent to a 0.03 normal solution of sodium chlorid. This concentration corresponds to 0.1755 per cent by weight of sodium chlorid, which is sufficient to give a slight salty taste to the water.

HABITAT.

While it is well recognized that the habitat of the wild rice plant is in shallow fresh water, it is now known that it will grow luxuriantly in water containing little less than two-tenths of 1 per cent of sodium chlorid. Occasional plants have been found growing in water which contained, for short periods at least, nearly double that amount of salt. These facts indicate the possibility of a much wider range of conditions to which this plant may be subjected without hindering its development. It is not beyond the range of possibility—indeed, it is quite probable—that by careful selection plants may be obtained which will thrive on soil that is comparatively dry, at least in places in which the water can be drawn off gradually during the latter part of the growing season.

In September, 1904, Mr. G. C. Worthen, of the Bureau of Plant Industry, collected a cluster of wild rice plants which were growing on the Potomac Flats, near Washington, D. C., in soil which was sufficiently dry to permit the use of a 2-horse mowing machine for cutting down the rank growth of vegetation. This was newly made land, and in all probability the seed giving rise to this cluster of plants was pumped in with the dirt from the Potomac River the year previous.

This amphibious type once established, it will undoubtedly carry with it a strain of seed which can withstand considerable drying without any marked injury to its vitality. Such being true, the methods and difficulties of propagation from seed would be greatly simplified.

Simultaneous with establishing an amphibious type should come the selection of seed plants which are capable of retaining their seed until the larger part of it has reached maturity. These two steps once made, the future of wild rice as a cereal will be assured.

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[a] The Salt Water Limits of Wild Rice. Bulletin No. 72, Part II, Bureau of Plant Industry, United States Department of Agriculture, 1905.

GERMINATION OF THE SEED.

The greatest difficulty to be overcome in extending the area for growing wild rice is the poor germination of the commercial seed. Inasmuch as wild rice constitutes one of the most important foods of wild ducks and other wild waterfowl, many individuals and most of the gunning clubs east of the Rocky Mountains have been asking the question, How can we propagate wild rice from seed in order to establish better feeding and fattening grounds for our game birds?

The many failures in the propagation of wild rice from seed have been due to the use of seed that had become dry before sowing, or to the fact that the seed when sown fresh in the autumn had been eaten by ducks or other animals or was carried away by heavy floods before germination took place.

It is now very generally known that the seed of wild rice, if once allowed to become dry, will not germinate, save possibly an occasional grain. In its natural habitat the seed, as soon as mature, falls into the water and sinks into the mud beneath, where it remains during the winter months, germinating the following spring if conditions are favorable.

Heretofore the plan generally followed, and the one usually recommended by those who have given some attention to the propagation of wild rice, was practically that of natural seeding; that is, to gather the seed in the autumn, as soon as thoroughly mature, and, while still fresh, to sow it in 1 to 3 feet of water.

FALL SEEDING VERSUS SPRING SEEDING.

It must be remembered that the bulk of the seed remains dormant during the winter, germinating first the spring after maturing; consequently, with but few exceptions, fall seeding is unsatisfactory and unreliable. Fall seeding is likely to prove a failure for three reasons: (1) Wild ducks and other animals of various kinds eat or destroy the seed in considerable quantity before it has had time to germinate the following spring; (2) much of the seed is frequently covered so deeply with mud that washes in from the shore during the winter that the young plants die of suffocation and starvation before they reach the surface; (3) in some cases a large quantity of the seed is carried away from the place where sown by the high waters and floating ice prevalent during the latter part of the winter and early spring.

In exceptional cases these difficulties can be overcome; under which circumstances autumn sowing may be preferable to spring sowing. In the majority of cases, however, much better results will be obtained if the seed is properly stored and sown in the early spring, as soon as the danger of heavy floods is passed and the water level approaches normal.

In sowing the seed considerable care must be exercised in selecting a suitable place, securing the proper depth of water, etc. Good results can be expected if the seed is sown in from 1 to 3 feet of water which is not too stagnant or too swiftly moving, with a thick layer of soft mud underneath.[a] It is useless to sow wild rice seed on a gravelly bottom or in water where the seed will be constantly disturbed by strong currents.

Previous to this time, save in a few reported cases, the seed which was allowed to dry during the winter and was sown the following spring gave only negative results. It is now definitely known that wild rice, if properly handled, can be stored during the winter without impairing the quality of germination to any appreciable degree, and that it can be sown the following spring or summer with good success.

DIRECTIONS FOR STORING THE SEED.

The vitality of wild rice seed is preserved almost perfectly if kept wet in cold storage—Nature's method of preservation. This method of storage implies that the seed has been properly harvested and cared for up to the time of storage. The seed should be gathered as soon as mature, put loosely into sacks (preferably burlap), and sent at once to the cold-storage rooms. If the wild rice fields are some distance from the cold-storage plant the sacks of seed should be sent by express, and unless prompt delivery can be guaranteed it is not advisable to send by freight even for comparatively short distances. It is very important that the period between the time of harvesting and the time when the seed is put into cold storage be as short as possible. If this time is prolonged to such an extent as to admit of much fermentation or to allow the seed near the outside of the bags to become dry during transit, its vitality will be greatly lowered.

It is not practicable to give any definite length of time which may elapse between harvesting and storing, inasmuch as the temperature, humidity, and general weather conditions, as well as the methods of handling the seed, must be taken into consideration. Let it suffice to say, however, that the vitality of the seed will be the stronger the sooner it is put into cold storage after harvesting.

As soon as the seed is received at the cold-storage plant, while it is still fresh and before fermentation has taken place, it should be put into buckets, open barrels, or vats, covered with fresh water, and placed at once in cold storage. If there is present a considerable quantity of light immature seed or straw, broken sticks, etc., it will be profitable to separate this from the good seed by floating in water

[a] Wild Rice: Its Uses and Propagation. Bulletin No. 50, Bureau of Plant Industry, United States Department of Agriculture, 1903.

preparatory to storing. The storage room should be maintained at a temperature just above freezing—what the storage men usually designate as the "chill room."

When taken from cold storage in the spring the seed must not be allowed to dry out before planting, as a few days' drying will destroy every embryo.

Seed which was stored under the foregoing conditions from October 19, 1903, to November 15, 1904, 393 days, germinated from 80 to 88 per cent. Another lot of seed, which was stored on October 6, 1904, and tested for vitality on April 17, 1905, germinated 79.8 per cent.

Plate I shows the luxuriant growth made by the seed which was kept wet and stored at a temperature of 32° to 34° F. for 393 days.

DETAILED CONDITIONS AND RESULTS OF STORAGE EXPERIMENTS.

The foregoing conclusions are based on the results obtained from two series of experiments, as follows:

In October, 1903, a box of wild rice seed was received from Ontario, Canada. This seed, as soon as gathered, was loosely packed in moist sphagnum and sent by express to the Seed Laboratory of the United States Department of Agriculture. After a few days, while it was yet moist and before any fermentation had taken place, the seed was divided into four lots for special treatment, as follows:

(1) Seed submerged in water and placed in cold storage at a temperature of 32° to 34° F.

(2) Seed submerged in water and placed in cold storage at a temperature of 12° F. The seed was soon embedded in a solid mass of ice and remained so until samples were taken for test.

(3) Seed, without the addition of water, put into cloth bags and kept in cold storage at a temperature of 32° to 34° F.

(4) Seed, without the addition of water, put into cloth bags and kept in cold storage at a temperature of 12° F.

In October, 1904, a second consignment of seed was received from Minnesota, and the following additional storage experiments were made by Mr. C. S. Scofield, of the Bureau of Plant Industry.

(5) Seed submerged in water and placed in cold storage at a temperature of 32° to 34° F., as in No. 1.

(6) Seed submerged in water and placed in cold storage at a temperature of 12° F., as in No. 2.

(7) Seed submerged in water in a galvanized-iron bucket and stored on the roof of the laboratory building. The water was changed daily when not frozen.

(8) Seed submerged in water in a galvanized-iron bucket and stored on the roof of the laboratory building, as in No. 7. In this case the water was not changed save to replace the loss due to evaporation.

(9) The conditions for No. 9 were the same as those for No. 8, except that air was forced into the water daily when not frozen solid.

Samples of seed were taken from the different lots and tested for vitality at irregular intervals throughout the time of storage, which, in the former series, extended over a period approximately thirteen months and in the latter series over a period of little more than six months.

Experiments Nos. 1 and 5.—The seed which was submerged in water and stored in the "chill room" showed no deterioration in vitality. The results of the final tests gave a germination varying from 79.8 to 88 per cent. This is practically Nature's method of preserving the vitality of the seed during the winter.

Experiments Nos. 2 and 6.—The seed which was submerged in water and stored at a temperature of 12° F. was all killed before the spring following the date of storage. Soon after being placed in storage the water was frozen solid and the seeds were embedded in a mass of ice, in which condition they remained throughout the experiment, a portion being cut out from time to time for germination tests. The complete loss of vitality in these two lots of seed is attributed not to the freezing directly, but to the thorough desiccation as a result of the continuous low temperature.

Experiments Nos. 3 and 4.—The samples of seed which were stored in cloth bags at the temperatures of 32° to 34° F. and of 12° F. had, for all economic purposes, entirely lost their vitality. The average percentage of germination, as shown by the 37 tests made from each of the two lots, was less than five-tenths of 1 per cent.

Experiment No. 7.—The seed which was submerged in water and stored on the roof of the laboratory building, the water being changed daily, showed a good percentage of germination when the last vitality tests were made. If only a small quantity of seed is desired for the spring planting and cold storage can not be readily secured, good results may be obtained by this treatment; but it is much less certain and probably more expensive than keeping the seed in cold storage, and for this reason is not recommended. The success of this method will likewise depend largely on the temperature of the water.

Experiments Nos. 8 and 9.—On April 22, 1905, samples taken from each of these two lots of seed showed a marked deterioration in vitality. Thoroughly mixed samples from No. 8 showed a vitality of only 58 per cent, while No. 9 had deteriorated to 14.3 per cent.

PACKING FOR TRANSPORTATION.

Too much care can not be given to the matter of packing the seed for transportation, for unless the packing is properly done the vitality of the seed will be destroyed during transit. What is here said applies to fresh seed which is to be sown in the autumn, as well as to seed which has been kept in cold storage during the winter. It must not be forgotten, however, that the vitality of cold-storage seed is more quickly destroyed on drying than that of fresh seed.

For transportation the seed should be carefully packed, with moist sphagnum, cocoanut fiber, or fine excelsior, in a loosely slatted box. If the time of transportation does not exceed five or six days no special precautions need be taken as to the temperature. During the period of transportation it is quite probable that some of the seed will germinate, but if sown at once growth will not be retarded and the roots will soon penetrate the soil and anchor the young plants.

If the time of transportation is necessarily long, it is recommended, if the best results are desired, that some provision be made for a reduced temperature. The nearer the temperature approaches that of freezing the better. It has been demonstrated, however, that a fair percentage of seed will remain germinable for a considerable time if packed as above described.

On October 10, 1904, Mr. C. S. Scofield sent a small quantity of wild rice, packed in moist sphagnum moss in a well-ventilated box, to Doctor De Vries, of Amsterdam, Holland. On October 14 or 15 this box was placed in cold storage on the steamer in New York Harbor. The box of seed was received by Doctor De Vries in good condition on November 2, twenty-one days after the seed was packed for shipment.

METHODS OF MAKING GERMINATION TESTS.

The samples were tested (1) between folds of blotting paper—our regular method for testing the germination of most seeds—and (2) in water, Nature's method of sowing wild rice seed. The latter method gave much better results and was the one finally adopted for the laboratory tests. The seed should be covered with water, the water in the dishes to be changed daily.

Plate I shows the importance of making the germination tests in water, as described in the foregoing paragraph. The seed was covered with water and placed in a germinating chamber maintained at an alternating temperature of 20° C. (68° F.) for eighteen hours, and 30° C. (84° F.) for six hours, until the majority of the seeds had germinated. At this stage the dish containing the seeds was transferred to the worktable, which was exposed to the temperature of the laboratory—approximately that of a living-room. The water in the

dish was changed daily during the period of germination, and water was afterwards added at irregular intervals to replace the loss by evaporation.

Plate II shows somewhat in detail the different stages in the germination of wild rice seeds. The seeds and seedlings are shown in natural size. In *b* and *c* the first sheath has just burst through the seed coats, taking a position at right angles to the seed proper. The lateral roots begin to emerge when the first sheath leaf has attained a length of ½ to 1½ inches. From this time growth continues rapidly, and by the time the seedlings are 2 or 3 inches long the root system is very well developed (*f* and *g*). At this stage under favorable conditions the plants have a good hold in the soil and will not be washed away by an ordinary freshet. The relative position of the actively growing seedling is always at right angles to that of the old seed, as shown in *f* and *g*.

EFFECT OF TEMPERATURE ON GERMINATION.

Germination tests were made at constant and alternating temperatures, ranging from 15° to 35° C. (59° to 95° F.). While no effort was made to show the minimum and maximum temperatures of germination, the percentage was somewhat reduced at a constant temperature of 35° C., and the maximum is not much above that. All of the other temperatures gave good results. The lower temperatures, however, were slightly more favorable than the higher. These facts are valuable to show that the wild rice plant can thrive in either warm or cold water, but better, perhaps, in northern than in southern latitudes.

SUMMARY.

(1) Under no circumstances should wild rice seed which is intended for planting be allowed to dry. Dried seed will germinate but rarely and should never be sown.

(2) Wild rice seed can be stored without deterioration if it is gathered as soon as matured, put into barrels or tanks, covered with fresh water, and, before fermentation has set in, stored at a temperature of 32–34° F. Seed treated in this way germinated as high as 88 per cent after being in storage 393 days. Fresh seed seldom germinates better, and usually not so well.

(3) After the seed is taken from cold storage it should not be allowed to dry. The vitality of cold-storage seed is destroyed on drying even more quickly than that of fresh seed.

(4) For transportation the seed should be packed in moist sphagnum, cocoanut fiber, or fine excelsior. If not more than five or six days are required for transit, no special precautions need be taken for controlling the temperature; but if the time for transportation exceeds

six days, provision should be made for a temperature sufficiently low to prevent marked fermentation. A temperature approximately freezing will give the most satisfactory results.

(5) Wild rice can be sown either in the autumn or in the spring. Spring sowing is preferable, thus avoiding the danger of having the seed eaten or destroyed by wild ducks or other animals during the fall or winter, or of its being buried or washed away by the heavy floods of late winter or early spring.

(6) Wild rice should be sown in the spring in from 1 to 3 feet of water which is neither too stagnant nor too swiftly moving, as soon as the danger of heavy floods is passed.

(7) Wild rice is of the greatest importance as a food for wild waterfowl, likewise a delicious breakfast food for man, and the area in which it is extensively grown should be extended. It will grow luxuriantly in either warm or cold water; furthermore, it can be grown successfully in water which is slightly salty to the taste.

(8) In determining the vitality of any sample of wild rice seed the germination tests should be made in water—the condition under which the self-sown seed germinates.

(9) The seed will germinate well at temperatures ranging from 15° to 30° C. The maximum temperature of germination is above 35° C. (95° F.), but better results are obtained at lower temperatures.

PLATES.

DESCRIPTION OF PLATES.

PLATE I. Wild rice growing in water. This seed was submerged at a temperature of 32–34° F. for approximately thirteen months. In making the germination test the seed was covered with water and placed in a germinating chamber maintained at a temperature of 20° C. (68° F.) for eighteen hours, and at 30° C. (86° F.) for six hours. After the majority of the seeds had germinated the dish was transferred to the worktable of the Seed Laboratory.

PLATE II. Progressive stages in the development of wild rice seedlings; *f* and *g*, seedlings showing the relative position of the growing seedlings and the parent seed, which take a position at right angles to each other when grown normally in water. (Natural size.)

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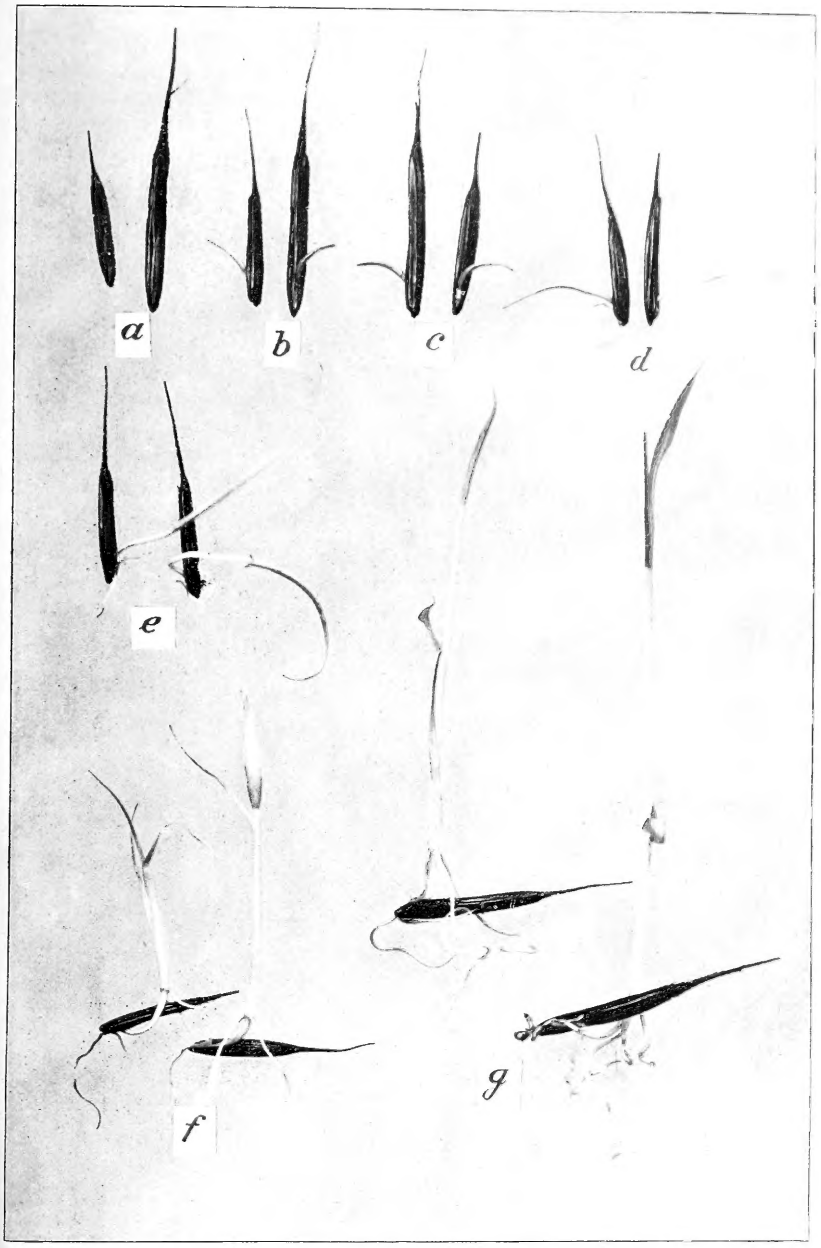
WILD RICE GROWING IN WATER AFTER BEING KEPT WET IN COLD STORAGE AT A TEMPERATURE OF 32-34° F., FROM OCTOBER 19, 1903, TO NOVEMBER 15, 1904.



STAGES OF GERMINATION OF WILD RICE, SHOWING THE DEVELOPMENT OF THE ROOT SYSTEM AND THE RELATIVE POSITION OF THE SEEDLING AND THE PARENT SEED. NATURAL SIZE.