

Respiration Studies on Germinating White-Oak Acorns

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Introduction. It is a well known fact that the respiration rates of germinating seeds commonly increase from a low rate for the dormant stage to relatively high values during active germination.¹ Dormant seeds are usually characterized by low moisture contents which may be as little as 11 per cent² or even less. Dormant white-oak acorns (*Quercus alba*), on the other hand, were found in this study to possess moisture contents of 35-45 per cent or sometimes greater. It is therefore of interest to examine their respiratory behavior during the course of germination.

Methods. Moisture contents were determined by drying in an electric oven for a specified period. A two-day period was used when drying was accomplished at 102° C. A five-day period and a temperature of 80° C. were employed when it was desired to use the dry material for further analysis. In all cases, the acorns were first cut into pieces in order to hasten drying.

Germination was accomplished in coarse, moist sawdust. Asphalt-painted cans with bottom drainage holes were filled with the sawdust and autoclaved for about one-half hour. The sawdust was then leached with several volumes of tap water. Prior to planting, the acorns were sterilized with a 0.25 per cent solution of Uspulum. Germination took place in the laboratory at room temperatures of about 20° C.

Respiration was measured in terms of oxygen consumption in a respirometer described by Girton.³ This respirometer is of the mercury-manometer type and accommodated 6 to 8 dormant acorns. Respiration measurements were made at 20° C. and at 25° C. for periods of 1.5 and 1.25 hours respectively. Duplicate determinations were made throughout.

Experiment No. 14. The oxygen absorption of germinating white-oak acorns over a twenty-day period is indicated in Figure 1. Respiration at 20° C. is here measured in cubic centimeters of oxygen absorbed per six acorns per 1.5 hours. These values, when plotted against days, give the trend of respiratory activity. It can be seen that, in this case, the rather high initial rate for the dormant acorns falls to the third day, after which the rate rises with time.

¹ Stiles, W. and Leach, W.; *Respiration in Plants*. Second Edition, Methuen, 1936.

² Raber, O.; *Principles of Plant Physiology*, Revised Edition, Macmillan, 1933.

³ Girton, Raymond E., A simple respirometer for quantitative class experiments. *Proc. Ind. Acad. Sci.*, **39**:119-122.

⁴ Described in detail by Park, Edgar R. A study of respiration in white-oak acorns. Thesis, Purdue University, 1941.

This fall in rate during the early stage of germination is not usual for germinating seeds. It seemed, therefore, of interest to make a study of composition changes in these acorns during germination. Ether extraction of the dried material brought out the interesting feature that there was an apparent reciprocal relationship between lipid content and the rate of oxygen absorption (Fig. 2.) It is evident from this figure

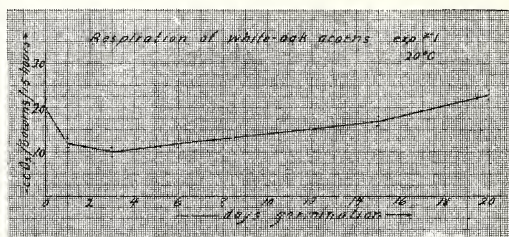


Fig. 1. Respiration of germinating white-oak acorns at 20° C.—experiment 1.

that during germination, the lipid percentage increased during the first three days and decreased thereafter. This initial increase in lipids may have been at the expense of soluble carbohydrates originally present in the dormant acorns. The subsequent decrease in the lipid content during germination and the accompanying increase in respiratory rate are in keeping with the generally accepted facts that the conversion of lipids to carbohydrates requires the addition of oxygen and that carbohydrates are the favored substrates of respiration.

Experiment No. 2. A similar study was carried out with white-oak acorns collected a year later from a different source. These acorns

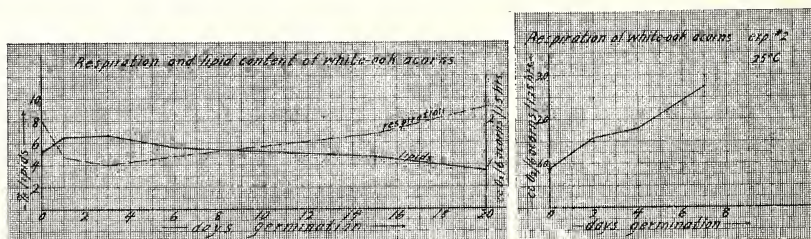


Fig. 2. Respiration and content of ether-soluble materials of germinating white-oak acorns—experiment 2.

Figure 3. Respiration of germinating white-oak acorns at 25° C.—experiment 2. Initial moisture content of the dormant acorns was 35 per cent.

had a moisture content of approximately 35 per cent while in the dormant condition. Germination was accompanied by an initial and continued upward trend in oxygen absorption at 25° C. This is shown in Figure 3. Here the initial rate was low and evidently does not decrease

during the early stages of germination. This behavior is similar to that of many seeds which have been studied in this respect.⁵

Experiment No. 3. The acorns used in this experiment had been collected after a rainy period and were therefore considerably more moist than those of the previous experiment. The average moisture content for this material was 46 per cent for the dormant acorns. We see from Figure 4 that in this case there is a suggestion of a depression in oxygen absorption with the first day of germination. The average rate for the third day, however, approximates that obtaining initially, and subsequent germination is associated with further increased respiratory rates.

Experiment No. 4. In this experiment an effort was made to correlate respiration with actual stage of germination instead of with time. Five classes of acorns were used. They were: dormant, and those with 0-3, 3-6, 6-9, and 9-12 centimeter primary roots. As can be

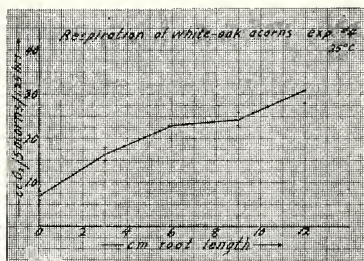
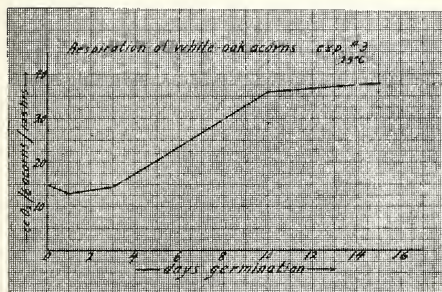


Fig. 4. Respiration of germinating white-oak acorns at 25° C.—experiment 3. Initial moisture content of the dormant acorns was 46 per cent.

Fig. 5. Respiration of germinating white-oak acorns at 25° C.—experiment 4. Respiratory rate plotted against growth of the primary root. Initial moisture content of the dormant acorn was 39 per cent.

seen in Figure 5, the rate of oxygen absorption increased continually with advancing germination. The dormant acorns had a somewhat lower moisture content (39 per cent) than those of experiment no. 3 owing to the storage in rather dry air. This may account for their low initial rate as compared with the dormant acorns of the previous experiment. The increased slope of the last segment of the curve is believed to be due to the advent of short lateral roots at this stage of development.

Discussion and conclusions. It is evident from the foregoing that the high moisture contents of acorns, as compared with many common seeds, is related to a high respiratory activity while still in the dormant condition. White-oak acorns, when placed under conditions favorable

⁵ Stiles, W. and Leach, W. Ibid.

for germination may, in some cases, show increasing rates of oxygen absorption from the very start. In other cases, and this appears to be associated with higher moisture contents, the initial respiratory rate may fall temporarily but again rises with time as germination goes on. In one case, at least, ether-extractable materials were shown to increase temporarily with this early fall. Finally, increased elongation of the primary root in germination is accompanied by an increased rate of oxygen absorption over a considerable period.