REVIEW OF RESEARCH
IMPACT FACTOR : 5.7631(UIF) UGC APPROVED JOURNAL NO. 48514 ISSN: 2249-894X
VOLUME - 8 | ISSUE - 7 | APRIL - 2019

VARIATIONS IN THE RESPIRATORY QUOTIENT DURING GERMINATION OF WHEAT SEEDS

Kanchan Kumari[1] and Gajendra Prasad[2]
[1]Research Scholar, Department of Botany, L.N. Mithila University, Darbhanga.
[2]Associate Professor, Department of Botany, L.N. Mithila University, Darbhanga.

ABSTRACT

Changes in germination, seedling growth, respiration, response to applied gibberellic acid, and glucose-U-C utilization were investigated in partially dormant wheat (Triticum aestivum L., Pa 151 × 107) seeds which were stored under various conditions for periods up to 1 year. Only seeds stored at −20 C and 12.4% moisture maintained partial dormancy, which was overcome by germinating in 10^{-3}m gibberellic acid. Germination and seedling growth of seeds stored at 25 C and 15.1% moisture declined within 12 weeks and the percentage of seeds infected with storage fungi increased. Gibberellic acid produced faster growing seedlings, particularly from those seeds with partial dormancy, but did not overcome growth reduction which was caused by deterioration. Seeds kept under laboratory conditions (B), 25 C and 12.1% moisture (C), and 25 C and 15.1% moisture (D) for 12 weeks utilized 35, 55, and 80% less glucose, respectively, than those stored at −20 C and 12.4% moisture (A). Seeds stored under B and C consistently had higher germination, growth, and respiratory rates than seeds from A and D. The respiratory rate declined as deterioration advanced under D. Respiratory quotients ranged from 1.0 for seeds stored under A to 1.6 for seeds stored under D.

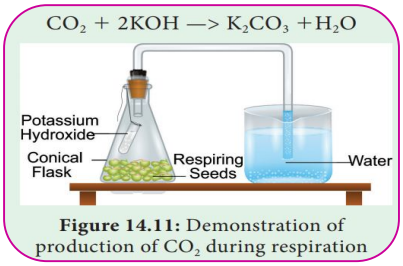

Figure 14.11: Demonstration of production of CO_2 during respiration

KEY WORDS : *Gibberellic Acid, Morphological Difference, Respiratory Quotient*

INTRODUCTION

Dormancy of seeds at maturity and for an extended period of time following harvest is of great importance to the life cycle of plants. Of the many investigations of this subject. those few which pertain to wheat indicate that varieties with red kernels are more resistant to sprouting than those with white kernels. All wheat varieties with white kernel color readily sprout at maturity; no exception has been found to date. In the varieties with red kernel color, varying degrees of dormancy ranging from strong to no dormancy at maturity and in the post harvest period have been observed. We initiated this study to determine the nature of dormancy in wheat and the possibility of breeding white wheat varieties with some of the dormancy characteristics of the red wheats. Many investigators have suggested numerous causes for dormancy in wheat. We have reinvestigated the following main hypotheses: A: impermeability of the seed coat to oxygen, B: impermeability of the seed coat to water, C: immature or dormant embryo, D: mechanically tough seed coat, and E: the presence of germination inhibitors in the seed coat. Some of these hypotheses arise from observations of morphological differences between kernels of wheat with red and those with white seed coats. The seed coat of the red wheats tightly covers the embryo whereas the seed coat of the white wheats is often separated from the embryo. This

difference suggests that water might enter the embryo of the white wheat more easily than that of the red wheat varieties. Wellington reported that the behavior of the covering or bran layers during germination indicated a difference in the mechanical properties of these layers in red and in white wheat kernels. After presenting data to disprove the first four hypotheses for wheat dormancy, we report data on the presence and partial purification of some of the germination inhibitors in the seed coat of wheat. Mosheov first demonstrated the presence of germination inhibitors in wheat kernels. Miyamoto and Everson investigating dormancy in wheat found a parallelism between the degree of pigmentation and the amount of catechin and catechin-tannins in the seed coat during the late dough stage of maturity. They suggest that the precursors of the seed coat pigments inhibited the germination of the embryo.

MATERIALS AND METHODS

Storage Conditions. Wheat (Triticum aestivum L., Pa 151 x 107) seeds grown in Pennsylvania and harvested in 1968 were stored under four sets of conditions which allowed changes to occur at different rates: A: -20 C and 12.4% moisture in closed containers, B: 21 to 26 C and 8.1 to 12.4%7o moisture, C: 25 C and 12.1 % moisture, and D: 25 C and 15 % moisture. Seeds stored in A underwent least change and maintained partial dormancy, seeds in B and C overcame dormancy, and seeds in D deteriorated rapidly. Moisture contents for B, C, and D conditions were obtained by storing seeds in the laboratory (25-50% RH') or over saturated solutions of Ca(NO3)2 (51% RH) and NaCl (75% RH) (17), respectively. Germination Tests. Seeds were surface-disinfected for 5 min with 1% sodium hypochlorite, rinsed three times with sterile distilled water, and germinated on sterilized absorbent toweling in distilled water or 10-3 M GA3 at 25 C in the dark. Seeds were also germinated in rolled towels at 20 C (4). Only those seeds which produced normal seedlings at 4 days were counted as germinated. Pathological Tests. The percentage of seeds from each storage condition infected with storage fungi was determined by placing surface-disinfected seeds on 10% NaCl malt agar (8) and storing the plates in a high humidity box in the laboratory for 10 to 20 days. The fungi growing from the seeds were classified as either storage or field fungi. Glucose Utilization. Seeds were imbibed in sterile water containing 50 Ag/ml each of penicillin G and streptomycin sulfate, then incubated in glucose-U-14C as described by Abdul-Baki. The CO2 was collected in either hyamine hydroxide or saturated Ba(OH). After incubation, the seeds were washed three times with ice-cooled water and were frozen until they were fractionated by a modification of the procedure described by Abdul-Baki. Seeds were homogenized in ice-cooled water, boiled for 45 min, cooled, made to 80% (v/v) ethanol, and kept at 4 C overnight. The preparation was centrifuged, and the supernatant was decanted and saved. The pellet was washed three times in 80% ethanol, and the washes were combined with the original supernatant. The supernatant contained the unutilized sugars, organic and amino acids, and other ethanol-soluble components. The precipitate contained the radioactivity which had been converted into polysaccharides and proteins. Aliquots of the ethanol-soluble and ethanol-insoluble (resuspended in water) fractions were taken for measurement of radioactivity by liquid scintillation using 10 ml of scintillation solution. Radioactivity in the BaCO3 was determined in this scintillator whereas the '4CO2 in hyamine was detected in a scintillator containing 4 g of 2, 5-diphenyloxazole plus 50 mg of 1, 4-di-2-(5- phenyloxazolyl)benzene per liter of toluene. Insoluble material was kept in suspension with Cab-o-sil.2 Counting efficiency ranged from 40% for the CO2 to 50% for the ethanol-soluble and ethanol-insoluble fractions. Utilization of glucose is defined as the percent of total uptake that appears in CO2 and ethanolinsoluble material. Respiration measurements were made in a Gilson respirometer as previously reported. Seed moisture was determined at 130 C in 19 hr.

RESULTS

Germination and Growth. The time courses for changes in percentage germination of seeds stored under four different conditions (Table I) show that seeds kept under A maintained or increased partial dormancy during 51 weeks of storage. Germination of seeds from C and B approached 100%, after overcoming partial dormancy during the first 6 and 12 weeks, respectively, and remained

unchanged. Seeds stored under D lost capacity for germination rapidly. In contrast to the germination percentages of seeds from D, which were not stimulated by GA3 (Table I) or by low temperature (Fig. 1), germination percentage of seeds of A in 10-3 M GA3 at 25 C or in water at 20 C were significantly in Table I. Effect of Storage Conditions and GA3 on Seed Germinationi at 25 C Surface-disinfected seeds were germinated in the dark for 4 days on sterilized absorbent toweling moistened withl either distilled water or 10-3 M GA3. Percentage germination is based on 100 seeds.

Weeks in storage	Germination							
	A[1]		B[2]		C[3]		D[4]	
	H_2O	GA_3	H_2O	GA_3	H_2O	GA_3	H_2O	GA_3
	%	%	%	%	%	%	%	%
0	81	99	81	99	81	99	81	99
6	87	92	86	99	95	89	81	85
12	66	93	95	92	94	91	75	74
18	40	96	96	96	96	96	67	64
26	71	95	96	92	96	98	27	21
36	70	92	100	100	99	94	1	0
51	60	98	97	94	97	97	...	...

-20 C and 12.4% moisture.
Laboratory (21-26 C and 8.1-12.4%o moisture).
25 C and 12.1% moisture.
25 C and 15.1% moisture.

DISCUSSION

Metabolic activity of the seed changes during storage, and these changes are probably responsible for overcoming post harvest dormancy and for deterioration. That changes do occur in seeds during storage was shown by differences in germination and seedling growth. Poor germination at 25 C of seeds from A was caused by postharvest dormancy, which is known to occur in some red wheat varieties. This type of dormancy, often eferred to as "high temperature dormancy", can be broken by germinating at a lower temperature (20 C). The high temperature dormancy was also overcome by germinating the seeds in GA3. In contrast, poor germination of seeds from D at 25 C with and without GA3 as well as at 20 C was not caused by dormancy but by deterioration. Thus dormancy was clearly separated from deterioration by these treatments. Dormancy of wheat seed has been attributed to seed coat (i.e., pericarp) inhibitors which decrease during storage. These data suggest that the inhibitors are stable under A, and that their gradual destruction at higher storage temperatures might account for the steady increase in seedling growth rates of seeds from B and C. On the other hand, growth decline of seedlings from seeds stored under D, being unrelated to dormancy, is perhaps best explained by deterioration to which storage fungi may have contributed significantly. However, storage condition rather than storage fungi has been cited as the primary cause of reduced germinability.

REFERENCES

1. Miyamoto T, Tolbert NE, Everson EH. Germination inhibitors related to dormancy in wheat seeds. Plant Physiol. 1961, Nov;36(6):739–746. [PMC free article] [PubMed] [Google Scholar] GERMINATION INHIBITORSq RELATED TO DORMANCY IN WHEAT SEEDS 1, 2 TAKAO MIYAMOTO 3, N. E. TOLBERT, & E. H. EVERSON DEPARTMENTS OF BIOCHEMISTRY & FARM CROPS. MICHIGAN STATE UNIVERSITY, EAST LANSING
2. ABDuL-BAKI, A. A. 1969. Metabolism of barley seed during early hours of germination, Plant Physiol. 44: 733-738.
3. ABDuL-BAKi, A. A. 1969. Relationship of glucose metabolism to germinability and vigor in barley and wheat seeds. Crop Sci. 9: 732-737.
4. ABDuL-BAKI, A. A. AND J. D. ANDERSON. 1970. Viability and leaching of sugars from germinating barley. Crop Sci. 10: 31-34.

5. ANDERSON, J. D. 1970. Physiological and biochemical differences in deteriorating barley seed. Crop Sci. 10: 36-39.
6. BRADBEER, J. W. AND B. COLMAN. 1967. Studies in seed dormancy. I. The metabolism of (2-14C) acetate by chilled seeds of Corylus avellana L. New Phytol. 66: 5-15.