Water Uptake and Germination of Wheat Grains in Different Solutions

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ABSTRACT

Wheat grains of Cv. Sedi Mesri 1, a short stemmed variety were germinated on blue blotters of the Kimpak type in a 25°C temperature controlled germinator with 100% humidity for 66 hours or until the radicle emerged. The increase in weight of the grain was recorded after 1,6,18,42 and 66 hours. The data on percent germination and the length of the radicle and plumule were measured at the end of the experiment. In each chemical solution, water absorption was the highest in 1–6 hour interval and the lowest in 42–66 hour interval. The germination percentage was affected by H_2O_2, KNO_3 and coumarin but not by thiourea. Hydrogen peroxide increased percent germination while KNO_3 and coumarin decreased it. The length of the radicle and plumule were increased by H_2O_2, decreased by coumarin and not affected by thiourea and KNO_3.

INTRODUCTION

Water is one of the most important factors affecting the germination of seeds. In the air dry seeds, the uptake of water in the first few hours is by imbibition and forms a large part of the total water uptake by the seeds. After this purely physical uptake of water, there is a period of very little water uptake, followed by another period of fast water absorption (2,6).

Water uptake is influenced by the osmotic pressure and the nature of the surrounding medium (4,5), the latter may affect the germination of seeds in the field and in the laboratory.

The purpose of this study was to determine the water uptake by wheat grains during germination in different chemical solutions and the effect of these chemicals on the germination of seeds and the growth of the embryo.

MATERIALS AND METHODS

Four lots, each of one hundred sound wheat grains of Cv. Sedi Mesri 1 were selected and weighed to get the air dry weight of the sample for each treatment. These were germinated as described earlier (5). The concentrations of different chemicals used were hydrogen peroxide (H_2O_2) – 0, 0.25%, 0.5% and 1.00%; Potassium nitrate, 0, 10^{-1} M,

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10^{-2}M, and 10^{-3}M: thiourea 0, 0.25×10^{-2}M, 10^{-2}M and 10^{-1}M and coumarin 0, 10^{-4}M, 10^{-3}M and 10^{-2}M. The percent water absorbed was calculated after placing seeds for 1, 6, 18, 42 and 66 hours in the constant temperature germinator. The percentage of germination, length of radicle and the length of plumule were measured at the end of each experiment (i.e. after 66 hours). There were four replications of each treatment and each chemical was considered as a separate experiment. The statistical analyses were done according to Steele and Torrie (7).

RESULTS AND DISCUSSION

Water Uptake

There was a significant effect of concentration on interval regarding water uptake in all chemicals.

Hydrogen peroxide Within a given concentration, water uptake was the highest in 1–6 hour interval followed by 0–1 and 6–18 hour intervals. The water uptake after 18 hours was very small in all concentrations except 0.5 % H_2O_2 in which it was higher than 6–18 hour interval (Table 1). Within a given interval, there was no effect of H_2O_2 concentration except after 18 hours when the relative water uptake was small.

It appears from the data that in seeds germinating in H_2O_2 water uptake is affected by time interval and not by concentration, 1–6 hour interval having the highest water uptake.

Potassium nitrate Within a given concentration water uptake was the highest in 1–6 hour interval followed by 0–1 hours and 6–18 hours. Unlike H_2O_2 however, the high water uptake continued till 42 hours instead of 18 hours. After 42 hours the water uptake was very low (Table 2). Within a given interval, this difference in water uptake was observed in 0–1 hour and 18–42 hour intervals. Check treatment had significantly lower water uptake than other concentrations in 0–1 hour interval.

Thiourea The water uptake was the highest in 1–6 hours interval in each concentration of thiourea. There was no significant effect of concentration within an interval except after 42 hours when the water uptake was higher in the check treatment and 10^{-2}M concentration than the other treatments.

Coumarin The water uptake was the highest in 1–6 hour interval (in each concentration of coumarin) than all intervals except 6–18 hours in which it was the same (except in the check treatment). The effect of concentration on water uptake was significant in 6–18 hour and 42-66 hour intervals only. The water uptake was high in 10^{-2}M concentration in 6–18 hour and 10^{-4}M concentration in 42–66 hour interval (table 4).

It appears that fast water uptake in wheat occurs not at the soaking but one hour later inspite of the fact that the seeds are soaked in different germination inhibitors and promotors. So this physical water movement is not affected by the type of the surrounding medium. The water uptake then decreases till 42–66 hours i.e. the time of radicle emergence when the water uptake is very low.

Percent Germination

The germination percentage of wheat grains was affected by hydrogen peroxide, potassium nitrate and coumarin concentrations but not by thiourea. The percent germination was increased over the check treatment by all H_2O_2 concentrations except 1 % in which case it was decreased (Table 5). The germination percent was decreased by

Table 1 The effect of hydrogen peroxide and time interval on mean water uptake by wheat grain during germination (g. water/100 g. air dry grain).

Interval hours	Hydrogen peroxide % 0.00	0.25	0.50	1.00
0–1	10.45	13.23	11.08	10.39
1–6	24.93	25.00	25.47	20.47
6–18	12.82	10.58	8.61	10.38
18–42	5.81	6.80	13.71	5.85
42–66	3.46	6.91	12.43	8.01

L.S.D. (.05) conc. within interval 4.10, Interval within conc. 3.27.

Table 2 The effect of different concentrations of Potassium nitrate on mean water uptake by wheat grain during germination (g. water/100 g. air dry grain).

Interval hours	Potassium nitrate concentration 0	10^{-3}M	10^{-2}M	10^{-1}M
0–1	7.94	13.09	10.68	13.78
1–6	17.67	18.05	20.30	19.23
6–18	13.56	13.64	14.67	14.10
18–42	14.88	11.33	7.51	11.07
42–66	5.43	4.79	6.69	5.91

L.S.D. (.05) Concentration within interval = 4.78, interval within conc. 2.94.

Table 3 The effect of different concentrations of thiourea on mean water uptake by wheat grain during germination (g. water/100 g. air dry grain).

Interval hours	Thiourea concentration 0	2.50×10^{-2}M	10^{-2}M	10^{-1}M
0–1	13.10	12.06	12.52	12.81
1–6	21.69	22.68	26.36	25.79
6–18	13.10	17.49	13.15	13.58
18–42	7.19	7.92	9.57	7.14
42–66	14.25	3.88	10.70	3.17

L.S.D. (.05) Conc. within interval 4.00, interval within conc. 3.49

Table 4 The effect of different concentrations of Coumarin on water uptake by wheat grains during germination (g. water/100 g. air dry grain).

Interval hours	Coumarin concentration 0	10^{-4}M	10^{-3}M	10^{-2}M
0–1	7.29	7.00	4.78	6.53
1–6	14.02	12.64	13.62	13.84
6–18	11.05	12.06	12.06	15.49
18–42	8.48	8.02	6.72	8.56
42–66	6.82	10.42	5.52	3.39

L.S.D. (.05) Conc. within interval = 2.04, interval within conc. = 1.74.

Table 5 The effect of different concentrations of Hydrogen peroxide on percent germination, length of radicle and length of plumule of wheat after 66 hours.

Concentration %	% Germination	Radicle cm.	Plumule cm.
0.00	29	0.54	0.09
0.25	32	0.44	0.11
0.50	48	1.26	0.15
1.00	8	0.12	0.02
L.S.D. (.05)	19	0.18	0.01

Table 6 The effect of different concentrations of Thiourea on percent germination length of radicle and length of plumule of wheat after 66 hours.

Concentration	% Germination	Radicle cm.	Plumule cm.
0	35	0.79	0.05
2.5×10^{-2}M	30	0.80	0.70
10^{-2}M	45	0.69	0.18
10^{-1}M	20	0.63	0.08
L.S.D. (.05)	N.S.	N.S.	N.S.

Table 7 The effect of different concentrations of Potassium nitrate on percent germination, length of radicle and length of plumule of wheat after 66 hours.

Concentration	% Germination	Radicle cm.	Plumule cm.
0	72	0.90	0.29
10^{-3}M	22	0.76	0.19
10^{-2}M	12	0.22	0.10
10^{-1}M	10	0.40	0.13
L.S.D. (.05)	16	N.S.	N.S.

Table 8 The effect of different concentrations of coumarin on percent germination, length of radicle and length of plumule of wheat after 66 hours.

Concentration	% Germination	Radicle cm.	Plumule cm.
0	98	1.6	0.8
10^{-4}M	91	1.8	0.7
10^{-3}M	66	0.6	0.2
10^{-2}M	0	0.0	0.0
L.S.D. (.05)	3	0.2	0.5

different concentrations of potassium nitrate (Table 7). In coumarin, percentage germination decreased gradually till 10^{-2}M concentration when there was no germination (Table 8). There appears to be no effect of water uptake in any interval on the germination percentage.

Growth of Embryo

The length of the radicle and plumule increased by H_2O_2 concentrations (Table 5) decreased by coumarin except 10^{-4}M concentration (Table 8) and was not affected by thiourea and potassium nitrate (Tables 6 and 7).

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