Water Uptake and Germination of Corn Grains in Different Solutions

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ABSTRACT

Corn grain of the open pollinated 'American Early' variety was placed on blotters moistened with different concentrations of hydrogen peroxide, thiourea and potassium nitrate for 42 hours until the radicle emerged in a 25°C temperature controlled germinator. The increase in weight of the grain was recorded after 6, 18 and 42 hours. The data on percent germination and radicle and plumule lengths were recorded at the end of the experiment. In all the three chemicals, the three phases of water absorption were observed.

INTRODUCTION

Seeds of different plants go through three phases of water absorption (1,6). These are: initial active phase of water absorption, steady phase of water absorption and fast use or rapid water absorption phase. The absorption of water is determined by the permeability of the seed coat or fruit coat (in legumes). The initial active phase of water absorption occurs during the first six hours, a large percentage of which may be in the first hour. This fast uptake is due to the swelling of the proteins with or without the effect of the semi-permeable membrane (3,4). Heat-killed seeds often imbibe more water than live seeds, but this absorption of water is limited to the first 12–14 hours; later there is no absorption (3).

Different solutes have promoting or inhibiting effect on the germination of many seeds. Nitrate ions, thiourea and hydrogen peroxide promote germination of many seeds like Lepidium, Eragrostis, Sorghum, Epilobium, lettuce and Gladiolus.

Potassium nitrate increased germination of Epilobium at 10^{-2} M concentration, lower (10^{-3} M) concentrations lowered the percentage of germination. The germination of lettuce in the dark increased by using 10^{-2} M to 10^{-3} M concentrations of thiourea (5). The purpose of this study was to determine the water uptake by seeds of corn, during germination in different chemicals. It was also to elucidate the effect of these solutes in depressing water uptake and in promoting germination.

MATERIALS AND METHODS

Four lots, each of one hundred sound corn grains of the American Early open pollinated variety, were selected and weighed to give the air dry weight of the sample for

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each treatment. They were placed on wet blotters (blue) of the Kimpak type in a temperature controlled germinator at 25°C for three different time intervals viz. 0–6 hours, 6–18 hours, 18–42 hours. The blotters were wetted by different concentrations of hydrogen peroxide, thiourea and potassium nitrate and drained to remove the excess liquid. The concentrations used were hydrogen peroxide 0.25, 0.50 and 1.00 %, thiourea 10^{-2} M, $2.5 - 10^{-2}$ M, 5×10^{-2} M, and 10^{-1} M, and Potassium nitrate, 10^{-1} M, 10^{-2} M, and 10^{-3} M. The control treatment was the distilled water. Each chemical was treated as a separate experiment. There were four replications.

The blotters were removed from germinators, grains wiped dry with paper towel and weighed at the end of each time interval. The increase in weight of grain at each time interval was considered as water uptake. The water uptake was calculated as a percentage of weight of air dry grain. At the end of the experiment, corresponding to the emergence of radicle with or without plumule the percentage of germination and the lengths of the radicle and plumule were measured. The data were analysed as given by Steele and Torrie (8).

RESULTS AND DISCUSSION

1. Water Uptake

(i) Hydrogen peroxide: The data on the effect of hydrogen peroxide on water uptake are given in Table 1. In the first and third intervals, hydrogen peroxide reduced the amount of water uptake; in the second interval, it had no effect. In the check treatment, the water uptake was higher in the first interval than second and third intervals (Table 1).

(ii) Thiourea: The data on the effect of thiourea on water uptake by corn grain are presented in Table 2. Water absorption was at highest level during interval 1, the lowest in interval 2 and intermediate in interval 3. There was no significant effect on different concentrations of thiourea on water absorption.

Table 1 The effect of hydrogen peroxide and time interval on mean water uptake by corn grain during germination at 25°C — g water/100 g air dry corn grain

	Hydrogen peroxide concentration %			
Interval hours	0.00	0.25	0.50	1.00
0–6	15.84	11.98	13.50	13.47
6–18	11.21	10.59	11.69	11.01
18–42	12.22	5.94	10.08	6.89
L.S.D. (.05)	1.75			

Table 2 Effect of different concentrations of thiourea on mean water uptake by corn grain at 25°C — g water/100 g air dry gain.

	Concentration						
Interval hours	0	10^{-2}M	2.50×10^{-2}M	5.0×10^{-2}M	10^{-1}M	MEAN	LSD (.05)
0–6	11.75	11.44	12.14	13.61	10.43	11.87	0.70
6–18	8.37	8.75	8.02	7.96	8.41	8.30	
18–42	10.00	9.66	8.84	9.05	10.98	9.70	

(iii) Potassium nitrate: The data on the effect of potassium nitrate on water absorption are presented in Table 3. Water absorption in the first interval was higher than the second interval in check and the highest concentration (10^{-1} M) of KNO_3. However water uptake was similar in both these intervals in other concentrations.

2. Percent Germination

(i) Hydrogen peroxide: The data on the effect of different concentrations of hydrogen peroxide on the germination percentage are given in Table 4. The percentage of germination decreased significantly in 0.25 % H_2O_2 over the check treatment. Increasing

Table 3 Effect of different concentrations of potassium nitrate and time interval on mean water uptake by corn grain during germination (25°C)—gm water/100 g air dry grain.

Interval hours	Concentration 0	10^{-3}M	10^{-2}M	10^{-1}M
0–6	11.91	9.75	10.15	11.99
6–18	8.19	9.12	9.92	7.32
18–42	5.16	6.95	10.14	9.29
L.S.D. (.05)	3.05	—	—	—

Table 4 The effect of different concentrations of hydrogen peroxide on the means of percent germination, length of radicle and length of plumule of corn during germination at 25°C.

Concentration %	% Germination	Radicle cm	Plumule cm
0.00	96	3.97	0.70
0.25	87	2.16	0.35
0.50	90	1.33	0.20
1.00	98	2.09	0.54
L.S.D. (0.05)	—	0.09	NS

Table 5 The effect of different concentrations of thiourea on means of germination, length of radicle and length of plumule of corn during germination at 25°C.

Concentration	% Germination	Radicle cm	Plumule cm
0	90	1.33	0.20
10^{-2}M	10	0.49	0.11
2.5×10^{-2}M	18	0.68	0.20
5.0×10^{-2}M	27	1.10	0.90
10^{-1}M	86	1.80	0.14
L.S.D. (.05)	12	0.79	NS

Table 6 The effect of different concentrations of potassium nitrate on means of percent germination, length of radicle and length of plumule of corn during germination at 25°C.

Concentration	% Germination	Radicle cm	Plumule cm
0	90	1.33	0.20
10^{-3}M	33	1.18	0.09
10^{-2}M	52	2.30	0.15
10^{-1}M	33	0.85	0.12
L.S.D. (.05)	39	0.85	NS

the concentration of hydrogen peroxide (over 0.25%) increased the germination percentage to the level of the check treatment.

(ii) Thiourea: 5.0×10^{-2} M to 10^{-2} M concentrations of thiourea reduced the percentage germination significantly over the check treatment. The germination percentage in 10^{-1} M thiourea was similar to check treatment (Table 5).

(iii) Potassium nitrate: The data on the effect of different concentrations of potassium nitrate on germination percentage are given in Table 6. All concentrations of potassium nitrate (10^{-1} M, 10^{-2} M and 10^{-3} M) decreased the percentage of germination. There was no difference among the different concentrations of potassium nitrate.

3. Length of Radicle

(i) Hydrogen peroxide: The length of the radicle decreased with the H_2O_2 treatment (Table 4). One half percent concentration had the shortest radicles. Radicles in 0.25% and 1.00% hydrogen peroxide were of the same size.

(ii) Thiourea: Thiourea had no effect on the length of the radicle except at the lowest concentration (10^{-2} M) in which case the length of radicle was decreased. Among the various concentrations, 10^{-1} M solution had significantly higher radicle length than 10^{-} M and 2.5×10^{-2} M concentrations (Table 5).

(iii) Potassium nitrate: There was no effect of potassium nitrate over check on the length of the radicle. Among the various concentrations 10^{-2} M resulted in the maximum length of radicle which was significantly higher than that encountered in 10^{-3} M and 10^{-1} M solutions (Table 6).

4. Length of the Plumule

There was no significant effect after 42–66 hours of hydrogen peroxide, thiourea and potassium nitrate on the length of the corn plumule (Tables 4, 5 and 6).

In the check treatment of each experiment, the three phases of water absorption were observed. The water absorption was highest in first interval.

Germination was decreased only in H_2O_2 solution (0.25%), the other concentrations of all chemicals except 10^{-1} thiourea depressed the germination over the control.

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