〈Article〉

Studies on the Acceleration of Germination in Carrot Seed (3)

Effect of some Inorganic Compounds on the Germination of Carrot Seed

Kwon, Oh Yong
(Andong Teacher's College)

당근 種子 發芽 촉진에 관한 硏究 (3)

당근 종자의 發芽에 있어서 몇가지 無機鹽類의 영향

權 五 溶
(安東敎育大學)

ABSTRACT

When germination beds of carrot seeds were treated with either 0.01M or 0.05M concentrations of $Ca(No_3)_2$, $CaSO_4$, $MgSO_4$, K_2SO_4 and KH_2PO_4, an acceleraion in the germination rate was observed in the groups treated with 0.01M KH_2PO_4 and 0.05M $MgSO_4$ and 0.05M $Ca(NO_2)_3$. In earlier work by the author with acetone a similar result was observed and reported. The pH range in these experiments was maintained between 5.0 and 6.0. It was found that the groups treated with 0.05M K_2SO_4, 0.05M $Ca(NO_3)_2$, 0.05M $MgSO_4$, 0.01M KH_2PO_4, 0.01M $Ca(NO_3)_2$ germinated earlier than the control group. The acceleration of the germination rate varied with the inorganic compounds used in the following descending order; 0.01M KH_2PO_4, 0.05M $Ca(NO_3)_2$, 0.05M K_2SO_4, 0.05M $CaSO_4$ and 0.05M KH_2PO_4.

As a result of these expriments, it occurs to the author that in the germination of carrot seeds some inorganic compounds appear to activate the osmotic function of carrot seeds causing acceleration in the germination rate.

INTRODUCTION

It had been reported by the author (kwon, 1968) that the treatment with acetone rather than phytohormone had accelerated the germination of carrot seeds, perhaps through the solution of an inhibitive lipid contained in them. At the same time it seemed to the author that the action of acetone might affect some components of resin, gum or wax, which is contained in the endosperm of the seed or

in the seed coat.

Additonally, a study of the accceleration of the germination rate of carrot seeds using of x-ray and ultraviolet light had been reported by the author in 1970.

Although studies on the germniation rates of various plants have been reported, relatively little is known about the effect of inorganic compounds in the germination of carrot seeds. In the course of studing the acceleration of seed germination rate, we were frequently faced with the possibility that plant growth might be accelerated by treatment with inorganic compounds. It is this possiblity which the author has made an effort to study.

MATERIALS AND METHODS

Daucus Carrota L. seeds imported from Japan, were used in these experiments. The methods used this experiment were similar to those described for *Nasturtium* seed by Fujii and Ishikawa (1962).

Groups of 100 seeds each, were treated with 0.01M or 0.05M concentrations of $Ca(No_3)_2$, $CaSO_4$, $MgSO_4$, K_2SO_4, and KH_2PO_4. The pH range was between 5.0 and 6.0. The pH of germination beds in these experiments were adjusted with HCl and KOH. Intially each germination bed was treated with 20 ml of the particular inorganic compounds being treated. Additional treatments depended on how much the seeds could take and still grow continuously.

Each dish for germination was wrapped with a thick black paper and the dish incubated at 25°—27°C during the dark period. on the third day after treatment with the inorganic compounds used, the hypocotyls of the germinated seeds were counted as a measurement of germination rate. The lengths of the hypocotyls were measured with vernier calipers.

RESULTS

The germination rate of the carrot seeds used was accelerated by treating them with adequate concentrations of some inorganic compounds. However, the growth rates were usually not as accelerated as those seeds treated with acetone (1969, 1970)

Table 1. Effect of some inorganic compounds on germination rate of carrot seed.

Treated group	Germination Period (%)				
	3	4	5	6	7 days
0.01M $Ca(No_3)_2$	26	56	66	79	85
0.05M $Ca(No_3)_2$	29	56	73	80	91
0.01M $CaSO_4$	16	43	57	67	81
0.05M $CaSO_4$	19	47	72	75	89
0.01M $MgSO_4$	18	42	71	78	91
0.05M $MgSO_4$	26	57	74	83	93
0.01M K_2SO_4	26	49	65	74	86
0.05M K_2SO_4	30	57	73	81	90
0.01M KH_2PO_4	25	58	75	86	98
0.05M KH_2PO_4	25	46	64	70	87
Acetone	23	56	72	79	93
Control	21	55	71	77	92

As shown in Table I, the group treated with 0.01M KH_2PO_4 was more accelerated than the control group, and the group treated with acetone.

At the same time, during the first stage of germination in the group treated with 0.01 M $MgSO_4$, accceleration did not appear as an obvious phenomena. However, the germination rate of this group during the medium stage of growth accclerated abnormally as compared with the control group.

The group treated with 0.05M $MgSO_4$ was more accelerated than the control group, as was the group treated with 0.05M $Ca(NO_3)_2$. It should be noted that this was true of the latter group only during the first stages of germination. The germination of the other groups, when compared with the control group, were rather delayed.

Table 2. Effect of some inorganic compounds on hypocotyl length of carrot seed

Treated group	Hypocotyl length(cm)				
	3	4	5	6	7days
0.01M $Ca(NO_3)_2$	0.6	1.3	1.9	2.5	4.7
0.05M $Ca(NO^3)_2$	0.3	0.9	2.0	3.0	4.3
0.01M $CaSO_4$	0.3	1.1	1.5	2.0	3.5
0.05M $CaSO_4$	0.9	2.2	3.0	3.5	4.0
0.01M $MgSO_4$	0.4	1.3	1.7	2.5	3.9
0.05M $MgSO_4$	0.5	1.4	2.0	3.5	5.0
0.01M K_2SO_4	0.2	0.8	2.5	3.0	4.3
0.05M K_2SO_4	0.6	1.5	2.0	3.2	4.3
0.01M KH_2PO_4	0.7	1.5	2.1	3.3	5.0
0.05M KH_2PO_4	0.5	2.1	2.2	3.0	4.5
Acetone	1.0	3.0	3.2	4.0	4.5
Control	0.3	1.2	1.7	3.0	4.3

The hypocotyl growth of groups treated with 0.05M $MgSO_4$, 0.05M KH_2PO_4 and 0.05 M K_2SO_4 was earlier than the control group as shown in Table 2.

A difference between the germination rate and the hypocotyl growth of carrot seeds in these experiments was slightly apparent.

It was indicated that the germination of carrot seed could be accelerated by adequate concentrations of $MgSO_4$, KH_2PO_4, K_2SO_4 and $Ca(NO_3)_2$

As shown in Fig.1, the germination rate of the group treated with 0.05M $Ca(NO_3)_2$ initially was more accelerated than the control group, but by the last stage germination lagged behind the control group.

Accordingly, it was indicated that the germination of carrot seeds could be accelerated

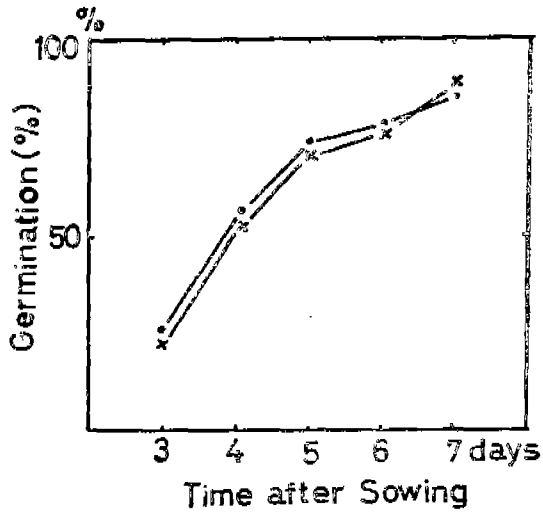

Fig. 1. Effect of 0.05M $Ca(NO_3)_2$ on the germination of carrot seed.
·——·——· 0.05M $Ca(NO_3)_2$
×——×——× Control group

by a 0.05M concentration of $Ca(NO_3)_2$. In this experiment, lower concentrations than used above did not appear to influence acceleration in the germination of carrot seeds.

In the group treated with 0.05M $CaSO_4$, the germination of the carrot seeds as compared

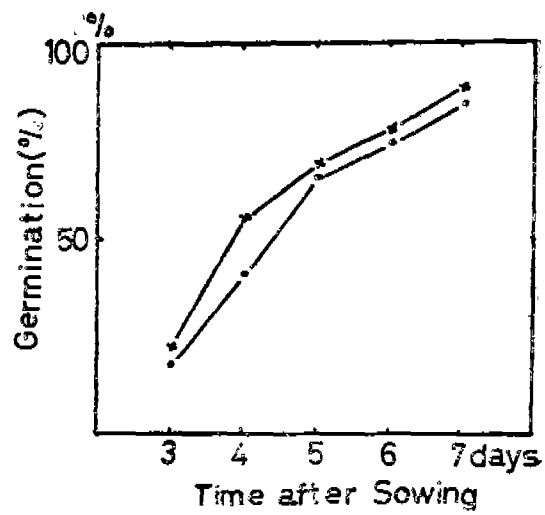

Fig.2 Effect of 0.05M $CaSO_4$ on the germination of carrot seed.
·——·——· 0.05M $CaSO_4$
×——×——× Control group

with the control group was not accelerated, but lagged at all stage of germination as shown in Fig. 2.

It Can thus concluded that some aqueous solutions of inorganic compounds induce an acceleration in the germination of some plant seeds.

The group treated with 0.05M $MgSO_4$ exhibit acceleration of the germination rate, over the control group and the other groups.

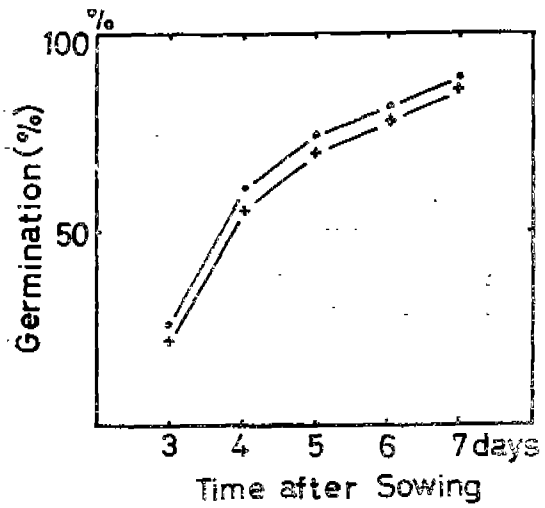

Fig.3 Effect of 0.05M $MgSO_4$ on the germination of carrot seed
·—·—· 0.05M $MgSO_4$
×—×—× Control group

It has been demonstrated in this experiment that the effect of adequate $MgSO_4$ among many inorganic compounds was sensitive in the germination of carrot seed.

In the group treated with 0.05M K_2SO_4, the germination rate was a little accelerated as compared with the control group.

In these experiments, the groups treated with 0.05M $Ca(NO_3)_2$wece accelerated but lagged behind the control group.

In Fig. 5, the germination rate of the group treated with 0.01M KH_2PO_4 was greater

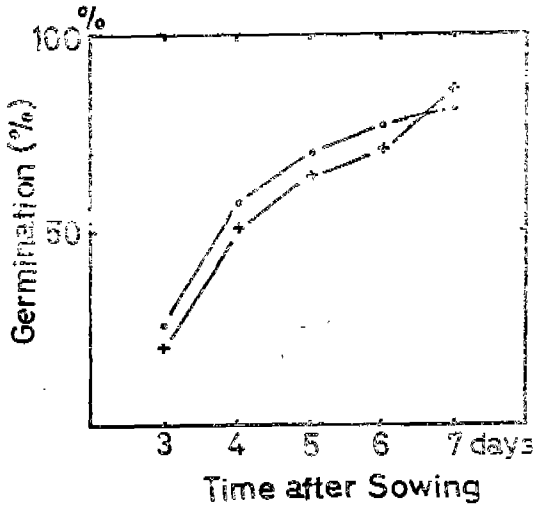

Fig.4 Effect of 0.05M K_2SO_4 on the germination of carrot seed
·—·—· 0.05M K_2SO_4
×—×—× Control group

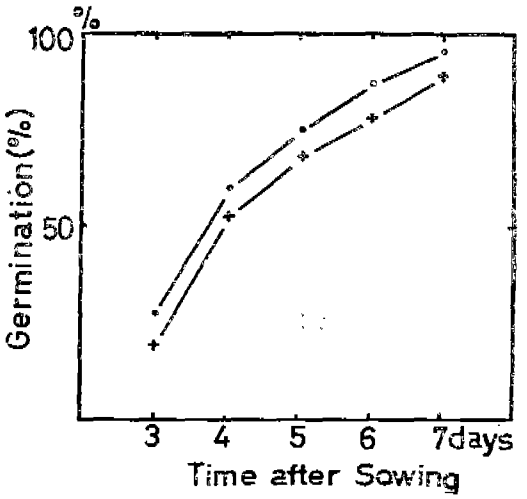

Fig.5 Effect of 0.01M KH_2PO_4 on the germination of carrot seed
·—·—· 0.01M KH_2PO_4
×—×—× Conrol group

than that of the control group as well as the group treated with 0.05M $MgSO_4$.

It was demonstrated that KH_2PO_4 and $MgSO_4$ in an adequate concentration of solution appeared obviously to accelerate the germination of carrot seed. It seemed to the author

that the adequate substrates of some inorganic compounds in the germination of carrot seed were added with 5-10 ml solution of 0.01M KH_2PO_4 and 0.01M $MgSO_4$.

DISCUSSION

The results of the present experiments demonstrated the influence of some inorganic compounds on the germination of carrot seeds. Specifically, it was characteristic that the germination rate and growth of carrot seeds were accelerated by 0.01M KH_2PO_4 and 0.05 M $MgSO_4$.

Takahashi (1962) reported that two pH optima between 2.0 and 3.0, and between 4.8 and 5.5 were observed when the pH of the germination beds was controlled with HCl-KOH, HCl-NH_4OH and HNO_3-KOH.

However, the pH of germination beds in these experiments was adjusted with HCl and KOH, and maintained at a pH range between 5.0 and 6.0. This was because the author intended to demonstrate some differences of growth rates by additon of suitable amounts of the inorganic compounds used. It was also reported by Kwon (1968) that the germination of carrot seed was greatly accelerated by treatment with acetone.

Ohda (1956) reported the long duration needed for the absorptive process of water in the germination of seeds, was due to perishable the time required for bacteria in the soil to act upon the seed coats. Thus, it was assumed that some chemicals acted upon the seed coat in a similar way accelerated the germination of the carrot seeds.

It was found that the germination rate of carrot seeds was weakly accelerated by some chemials and antibiotics, as compared with the acetone treatment. In this study, the germination rate and growth of carrot seeds was obviously increased by 0.01M KH_2PO_4 and 0.05M $MgSO_4$

Kwon (1968) reported that when compared with the control group, suitable treatment with X-rays and irradiation with ultravioelt light accelerated the rate of growth. It has been shown that the germination of carrot seeds could be accelerated by stimulation with antibiotics, organic reagents, phytohormone, radiation rays, organic acids, or inorganic compounds.

The ultimate problem was to study how some inorganic compounds effected physiological functions in the endosperm and seed coat. These experimental results indicate that the metabolism in both the endosperm of seeds and seed coats were activated by some inorganic compounds. The author feels that this was due to the effect of some kinds of inorganic solutions on the osmotic processes in the seed coat.

摘 要

당근 종자의 발아에 있어서 無機鹽類 0.01M 또는 0.05M 농도의 $Ca(NO_3)_2$, $MgSO_4$, KH_2PO_4 K_2SO_4, $CaSO_4$로 처리하였을 때에, 이 중 0.01M KH_2PO_4, 0.05M $MgSO_4$, 0.05M $Ca(NO_3)_2$의 처리구에서만이 비교적 Control 구 보다 촉진된 것으로 미루어 보아 이것은 알맞는 無機鹽類의 농도에서 당근 종자의 발아가 촉진된다는 可能性을 나타내었고, 따라서 두기염류의 작용이 종자의 발아생리에 많은 영향을 나타낼 수 있음을 의미하는것이었다.

지난번 저자의 實驗報告(1)에서는 植物生長素가 처리구보다 유기용제인 Acetone 처리구에서 당근 종자의 발아가 으히려 촉진되었다. 그러나 이 실험에서는 알맞는 농도의 두기염류의 처리구가 Acetone 처리구보다 발아가 더 촉진되고 있음은 發芽抑制物質을 제거하는

것도 발아촉진에 중요한 요인이 되겠다고 하겠으나 알맞는 농도의 무기 염류작용으로 세포의 생리기능이 조절되어 발아가 촉진되고 있음을 示唆하는 것 같다.

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