Photo-, Thermo- and GA-Sensitivity in Seed Germination of *Solanum tuberosum*

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Photo- or thermo-sensitivity in the germination of potato seeds varied with the variety and the progress of after-ripening of the seeds. The effect was markedly greater in light irradiation than in high-temperature treatment, and low-temperature treatment had a little effect.

When the application of GA brought about high germination at constant temperatures in continuous darkness. But the effect of GA was also considerably various with the variety and the physiological state of the seeds.

The germination of many seeds is known to be controlled by a light- or thermo-sensitive mechanism^(1,2,3,5,10,11,12,13). Some seeds are brought into germination by the repetition of short irradiation as well as long irradiation^(6,14).

The genetics of photo- or thermo-sensitivity in seed germination have also received some study^(4,7).

GA is known to stimulate seed germination of many plants, and sometimes the application of GA substitutes light, low- or high-temperature treatment and daily alternating temperatures which are required for germination^(1,8,9,10,11).

In the present work, the change in sensitivity of potato seeds to light, temperature and GA were studied at their various stages of maturity, using two culture varieties, their reciprocal hybrids, and five natural varieties.

MATERIALS AND METHODS

The potato (*Solanum tuberosum* L.) used were cultivated at an experimental farm of crop science in Hokkaido National Agricultural Experiment Station in 1966 and 1967. The seeds were harvested from fruits 50 and 60 days after artificial intra- or inter varietal pollination of flowers which were selected from a specified position on the main stem

(these seeds are referred to as group *a* and *b*, respectively). The seeds were air-dried and stored in a desiccator at room temperature.

The seeds to be tested were disseminated on two layers of filter paper in a Petri dish 4 cm in diameter and moistened with 1 ml distilled water. Then, the dishes were wrapped with light-tight paper which was removed when the seeds were irradiated. And these were placed in temperature-controlled chambers ($\pm 0.2^\circ\text{C}$).

A "cool white" fluorescent lamp was used as the source of white light, and light intensity at the level of seeds was adjusted to 500, 1,000 and 1,500 lux.

Four dishes contained 50 seeds respectively, each used for each treatment, and the germination percentage were counted 7 days after sowing.

RESULTS

Photo-sensitivity in seed germination

As shown in Fig. 1, seeds in the initial stage of after-ripening (0–6 months after harvest) had low germination percentages at a constant temperature of 20°C in light or in darkness. Eight to ten months after harvest, the seeds of both Eniwa and Oojiro showed rather low germination percentages at a constant temperature of 20°C in light. Twelve months after seed sampling, the germination percentage was higher when seeds were kept in light than in darkness. Especially, the

* Abbreviation: GA, gibberellic acid.

Fig. 1 Germination percentage of potato seeds at constant temperature (20°C) in light or in darkness at different stages of after-ripening

△ Eniwa seeds, ○ Oojiro seeds in light.
▲ Eniwa seeds, ● Oojiro seeds in darkness.

seeds of Oojiro germinated very well in light, but they almost did not germinate in darkness.

Further, the germination percentage in the seeds of their reciprocal hybrids lay between those of Eniwa and Oojiro in darkness (Table 1).

Table 1 Germination percentage in seeds of two culture varieties of potato, and their reciprocal hybrids in light or darkness (After-ripened twelve months)

Seed parent	Pollen parent	Percent of germination			
		Group a seeds		Group b seeds	
		Light	Darkness	Light	Darkness
Eniwa	× Eniwa	83	44	78	47
Oojiro	× Oojiro	98	1	89	3
Eniwa	× Oojiro	90	28	99	27
Oojiro	× Eniwa	98	31	98	26

Germination temperature 20°C.

The seeds of *S. chacoense*, *S. stoloniferum* and *S. phureja* showed higher percentage in light than in darkness, too. The seeds of *S. acaule* and *S. demissum* did not bring high germination either in light or in darkness six months after harvest, but they showed high germination in light in twelve months (Table 2).

The germination of Oojiro was also promoted by a very short single light irradiation

Table 2 Germination percentage in seeds of five natural varieties of potato (Group b seeds)

Variety	Percent of germination			
	After-ripened for six months		After-ripened for twelve months	
	Light	Darkness	Light	Darkness
<i>S. acaule</i>	8	0	76	14
<i>S. chacoense</i>	32	19	85	43
<i>S. stoloniferum</i>	46	0	87	46
<i>S. demissum</i>	12	0	93	21
<i>S. phureja</i>	62	40	87	74

Germination temperature 20°C.

Fig. 2 Effects on germination of light irradiation given with various intensities and for various durations after 48 hr imbibition at constant temperature (20°C) in darkness

Oojiro, group a seeds, and after-ripened for twelve months.

○ 500 lux, ● 1,000 lux, × 1,500 lux.

for 1/2 or 1 min, irrespective of light intensity (Fig. 2).

Thermo-sensitivity in seed germination

As shown in Fig. 3, the effects of single high (35, 30 and 25°C) or low (10°C) temperature treatment on germination were greater in 35° than 30°, 25° and 10°C in the seeds of both Eniwa and Oojiro, and they were hardly appreciable in 25° and 10°C.

The effects of single high-temperature (35° and 30°C) treatment were hardly appreciable, too, if the seeds were treated for less than ten minutes. And a single high-temperature treatment for thirty minutes was the greatest in the seeds of both Eniwa and Oojiro.

Fig. 3 Effects on germination of high- or low-temperature treatments given for various durations after 48 hr imbibition at constant temperature (20°C) in darkness (Group *a* seeds, and after-ripened for twelve months)
 ▲ 35°C, △ 30°C, ● 25°C, ○ 10°C.

Fig. 4 Effects of GA of various concentrations on the germination of potato seeds at constant temperature (20°C) in darkness (Group *a* seeds)

(A) ○ Eniwa seeds, ● Oojiro seeds.

(B) ○ *S. phureja*, ● *S. demissum*, △ *S. stoloniform*, ▲ *S. acaule*, × *S. chacoense*.

Effects of GA on seed germination

The results of the experiment are shown in Fig. 4. One to six months after sampling from fruits, the seeds of both Eniwa and Oojiro hardly germinated in darkness without GA treatment, but they germinated when GA was applied, and the germination percentage increased with an increasing concentration of GA. Twelve months after harvest, the seeds of both Eniwa and Oojiro showed fairly high germination percentages even when treated with GA of low concentration (Fig. 4-A).

The seeds of five natural varieties hardly germinated also in darkness when GA was applied one month after harvest. Six months after seed sampling, the seeds of *S. stoloniform* showed fairly high germination in darkness when GA of low concentration (25, 50 ppm) was applied, but the seeds of *S. demissum* and *S. acaule* hardly showed high germination in darkness even when GA of high concentration (100 ppm) was applied (Fig. 4-B).

DISCUSSION

The photo- or thermo-requirement in seed germination differs according to the kind, species, and variety or endogenous physiological conditions of seeds^(1,3,5,6,11,12,13).

In the experiments, the effect on the seed germination of potato was markedly greater in light irradiation than high- or low-temperature treatment. And also it was much greater in high-temperature than in the case of eggplant and *Physalis*, the low-temperature treatment had more effect than high-temperature^(11,12).

The photo- or thermo-requirement in the germination of potato seeds was remarkably various with the variety and the progress of after ripening of the seeds.

On the genetics of photo- or thermo-requirement in seed germination, HONING⁽⁴⁾ found that reciprocal crosses did not always results in seed that had exactly identical sensitivities to light. In general, however he observed that either parent could effectively control the need for light but that the female frequently exercised a slightly greater influence than male. KUGLER⁽⁷⁾ working with reciprocal crosses between light-requirement and light-indifferent condition was dominant.

But the genetics of photo- or thermo-requirement in the seed germination of potato must be studied more minutely, for the seeds of potato are heterozygous.

Photo- and thermo-sensitivity in seed germination is eliminated or replaced in certain cases by the action of GA^(8,9,10,11).

The photo-, thermo- and GA-sensitivity in seed germination of potato has heritable character, but also they various according to the endogenous physiological state caused by the progress of after-ripening of the seeds registered by the number of months from sampling to seed-test. And also the progress of after-ripening of the seeds varies according to ripening and after-ripening of the seed fruit registered by the number of days from pollination to seed-sampling.

To make clear the germination behavior of potato seeds, the endogenous physiological condition are as important as genetical factor of the seeds.

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ジャガイモ種子の発芽と光，温度，ジベレリン感受性

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ジャガイモ種子の発芽に対する光，温度，ジベレリンの効果は，ジャガイモの変種，あるいは品種そして種子の後熟度の進行による生理的条件によって著しくことなる。

また温度処理より光の照射効果が著しく，後熟 12 ケ月の種子ではきわめて短時間の光照射で高い発芽率が認められる。低温処理の効果はほとんど認められない。し

たがっておなじナス科植物でも，ナス，ホオズキとはことなる。

ジベレリンの効果も，ジャガイモの変種あるいは品種，そして種子内部の生理的条件によって著しくことなる。

ジャガイモ種子の発芽性をあきらかにするためには，遺伝的条件とともに種子の生理的条件についても考慮して行なうことが重要である。