April 2021

Effect of Gibberellin on the Germination of Bracted Plantain (Plantago Aristata MICHX.)

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EFFECT OF GIBBERELLIN ON THE GERMINATION OF BRACTED PLANTAIN (PLANTAGO ARISTATA MICHX.)[1/]

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Much information has been developed in the last several years on the effect of gibberellins on plant growth and reproduction.(7)[2/] There have been only a few reports, however, concerning the effect of gibberellin on seed dormancy. Lona (5) and Kahn et. al.(4) found that gibberellin could substitute for red light in lettuce germination. Barton (1) showed that the physiological drawfism of seedlings from non-vernalized seeds of Malus arnoldiana could be overcome by gibberellin treatment. She also reported (2) that epicotyl dormancy in tree peony was broken by gibberellin. Helgeson and Green (3) found that germination of secondary wild oat seed was much higher when 50 ppm. gibberellic acid was used as moistening agent than when distilled water was used. Rate of emergence of some kinds of non-dormant seed was increased by gibberellin treatment (8).

Steinbauer and Grigsby (6) have recently reported on the germination and dormancy characteristics of several species of Plantago. Freshly harvested seed of P. Rugeli and P. major exhibited primary dormancy. Dormancy was broken by a combination of 0.2 percent potassium nitrate as moistening agent, 1 to 2 weeks prechill at 5°C., a germination temperature of 20-30°C., and an 8-hour photoperiod. They stated that newly harvested seeds of P. lanceolata and P. aristata did not exhibit primary dormancy as satisfactory germination was obtained without prechill treatment.

Materials and Methods

Bracted plantain seeds were harvested at several locations in the vicinity of Starkville, Mississippi in the summer of 1957. The collections were air dried, bulked, cleaned, and stored in a laboratory for seven months before the experiments were initiated.

Filter paper in Petri dishes was used as the germination substratum. Moistening agents were 0.2 percent potassium nitrate, various concentrations of the potassium salt of gibberellic acid[3/] in aqueous solution, and distilled water. Temperatures were maintained within ± 1°C. Light when used was supplied by white fluorescent bulbs yielding about 100 foot-candles for 8 hours per day. Darkness was obtained by placing the Petri dishes in black plastic boxes. Two or four 100 seed replicates were used in assessing the effect of each treatment.

Results

Germination of non-gibberellin treated seeds of bracted plantain was stimulated by light and greatly influenced by temperature (Table 1). Germination percentages at 20°C. and 20-30°C. under equivalent conditions of light and darkness were comparable. A few seeds germinated at 15°C. in the dark. Germination did not occur at 10°C., 30°C., or 35°C.

Gibberellin treatment had several apparent and pronounced effects on germination of bracted plantain. Within the temperature range where some germination of non-treated seeds occurred, gibberellin treatment promoted germination of all viable seeds. Treatment with gibberellin greatly extended this range, complete germination occurring at temperatures as low as 10°C. and as high as 30°C; a moderate number of the seeds germinated even at 35°C. The need for light was eliminated except at the 10 ppm. level of gibberellin treatment and at 35°C. Less than 50 percent of the seeds, however, germinated at 35°C. even under light. This temperature was so adverse that the seedlings

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1/ Journal Paper No. 738 of the Mississippi Agricultural Experiment Station. This work was supported in part by a grant from Merck and Co., Inc., Rahway, New Jersey.

2/ Refers to literature cited.

3/ Supplied by Merck and Co., Inc., under the trade name "Gibrel." For brevity the chemical is designated as gibberellin throughout this report; it is equally active with gibberellic acid on a molar basis.

Table 1. Germination of bracted plantain treated with various concentrations of gibberellin at various temperatures and in light and darkness.

Temperature	Treatment	Gibberellin ppm.				
		0	10	100	500	1000
10° C.	Dark	0	—	--	94	--
15° C.	Dark	6	—	--	94	--
20° C.	Dark	24	40	96	93	--
	Light	60	95	92	96	--
20-30° C.	Dark	25	70	96	97	96
	Light	71	91	95	97	97
30° C.	Dark	0	40	96	96	97
	Light	0	55	91	93	92
35° C.	Dark	0	—	—	10	7
	Light	0	—	--	48	42

grew to about one inch in length and then most of them died unless removed to a more favorable temperature. The 10 ppm. concentration of gibberellin was not sufficient for complete germination at 20° and 20-30°C. without light. At 30°C. it was not sufficient even with light.

Gibberellin treatment not only had an effect on total germination, it also greatly accelerated germination. Data on speed of germination of seeds moistened with water, 10 and 500 ppm. gibberellin at 20-30°C. under light and in darkness are presented graphically in Figure 1. Complete germination of seeds moistened with 500 ppm. gibberellin was obtained within 3 days; germination of the seeds moistened with 10 ppm. (dark) and water did not level off until after 8 to 12 days. Gibberellin treatment appeared to have little effect on rate of seedling growth.

As in the case of many kinds of seed, germination of bracted plantain is stimulated by moistening the seeds with low concentrations of potassium nitrate in aqueous solution. The comparative performances of KNO_3 (0.2 percent solution) and gibberellin (500 ppm.) as germination stimulators were evaluated at several temperatures under light and darkness.

The percentage germination of seeds treated with 0.2 percent KNO_3 at 20°C. and 20-30°C. under light was essentially equivalent to that obtained from gibberellin treated seeds. Rate of germination however, was slower for the KNO_3-light combination. Under dark conditions (Figure 2))KNO_3 had a stimulating effect on germination at 15°, 20°, and 20-30°C. The stimulating effect of KNO_3 was considerably less than that of gibberellin. Potassium nitrate had no effect on germination at 10°, 30° and 35° C. The seeds did not germinate at these temperatures.

Discussion

Steinbauer and Grigsby (6) concluded from their studies of germination and dormancy in species of Plantago that bracted plantain did not exhibit dormancy. This conclusion was apparently based on the fact that a low temperature pretreatment was not required for germination of bracted plantain; light in combination with KNO_3 was sufficient. Although no completely satisfactory definition of seed dormancy has been presented, the requirement of special treatments, e.g., light of KNO_3, for germination, would seem to be a criterion of dormancy -- particularly as the need for these special treatments

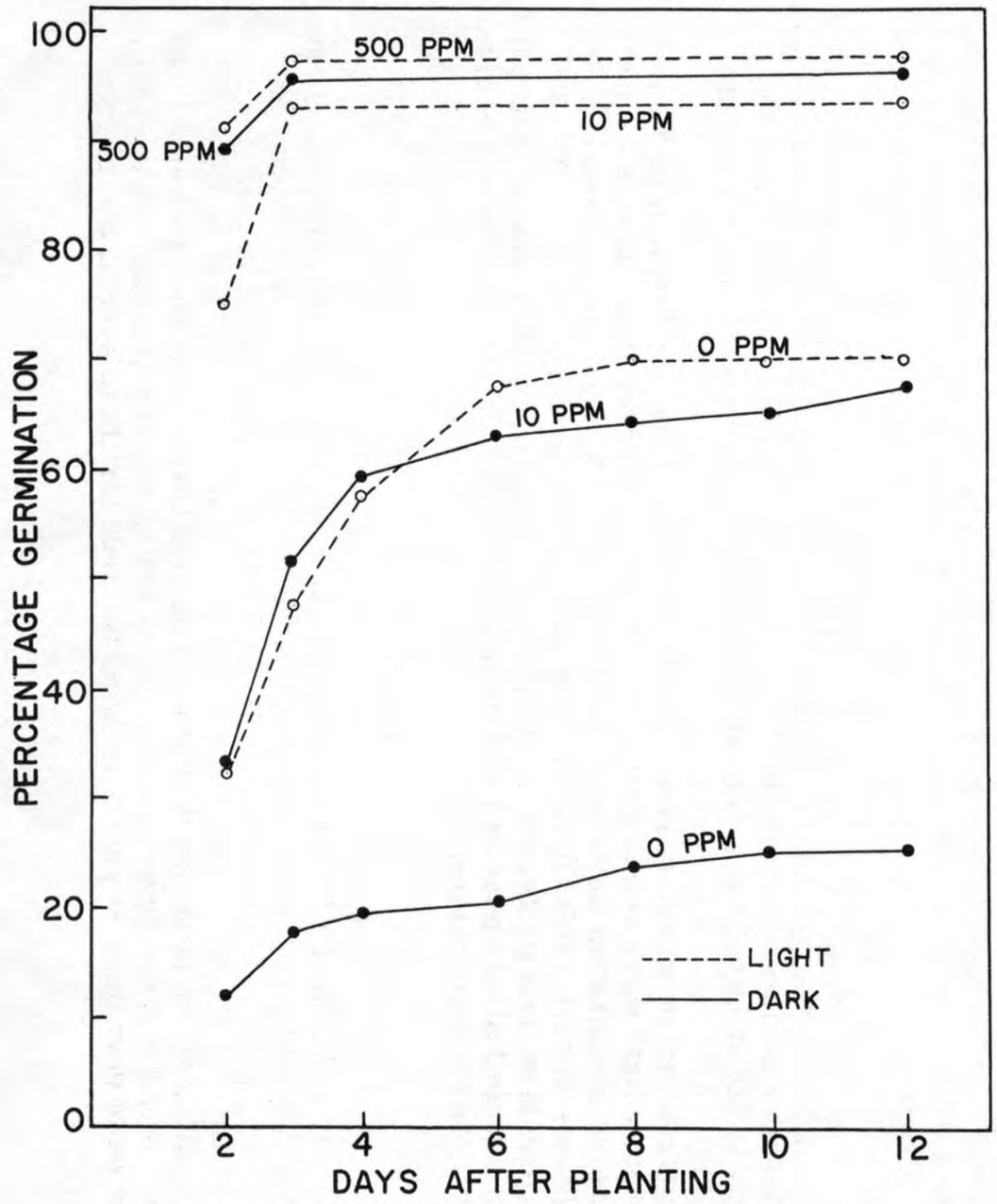

Figure 1. Effect of gibberellin on rapidity of germination of bracted plantain in light and darkness at 20-30°C.

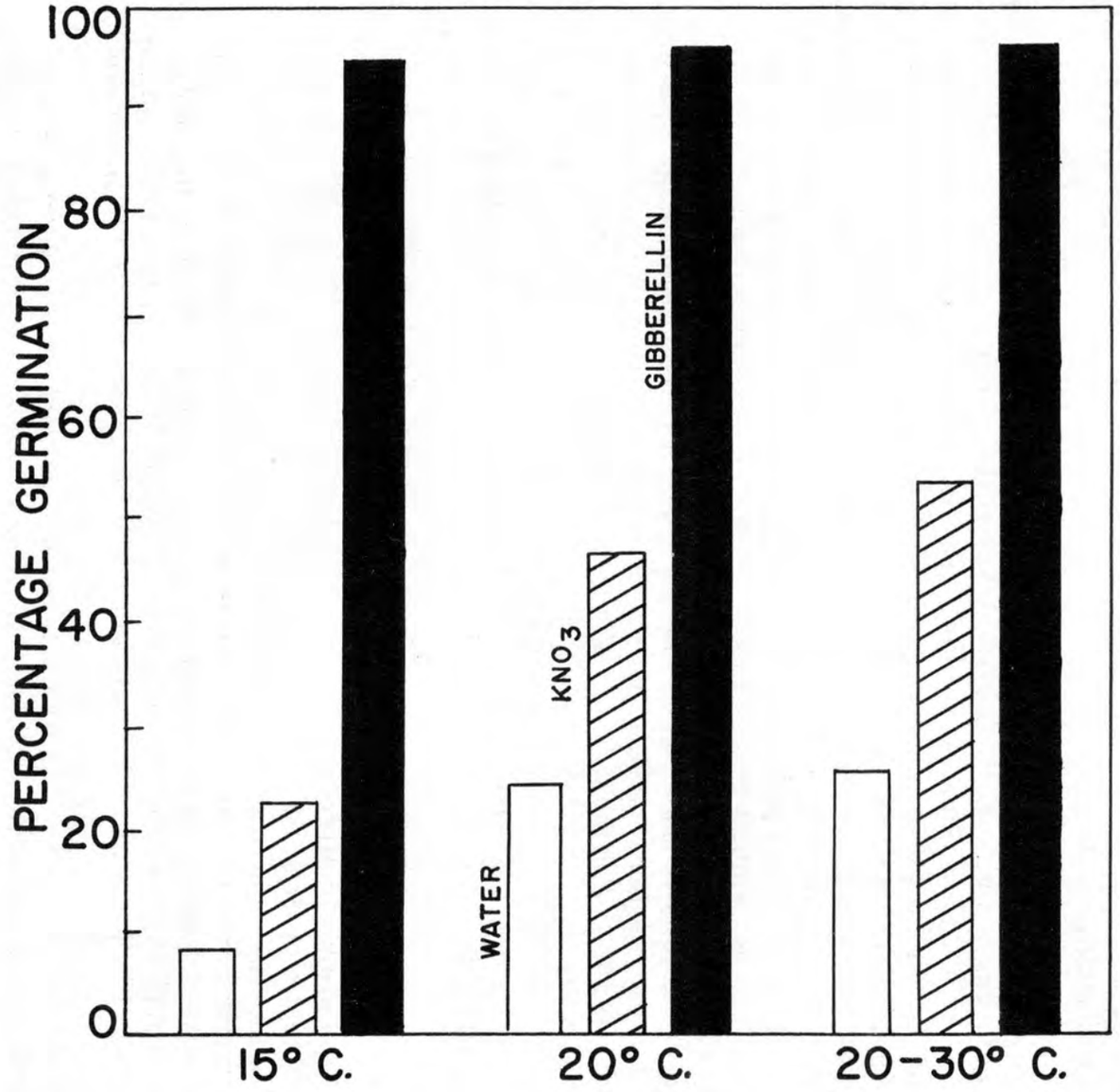

Figure 2. Comparative germination of bracted plantain at different temperatures in darkness when moistened with water, 0.2 percent KNO_3 and 500 ppm. gibberellin.

diminishes with time. For the purposes of this discussion, seed dormancy is considered to be the major factor involved in the germinative responses of bracted plantain to light, KNO_3, and gibberellin treatment.

Seed dormancy in bracted plantain was overcome by gibberellin treatment. The temperature range over which germination normally occurs was greatly extended. The need of light for germination was eliminated, except at the lower treatment levels and at 35°C. At 30°C. and 35°C. light alone or in combination with KNO_3 had no effect on germination as the seeds did not germinate under these conditions. At 30°C. when the higher concentrations of gibberellin were used the possible effects of light when combined with the gibberellin treatment were obscured. However, when light was applied in combination with low concentrations of gibberellin, it appeared to have an effect beyond that of the gibberellin. At 35°C. only 10 percent of the seeds germinated in darkness even at 1000 ppm. gibberellin; when light was applied, germination was about 50 percent.

Thus, a simple substitution of gibberellin for light does not seem to be involved. Under most of the conditions of these experiments, gibberellin had an effect on percentage germination and the temperature range of germination, beyond that of light and independent of light. Under other conditions, light enhanced the responses to gibberellin but was dependent on gibberellin for its effect. It is quite possible, of course, that the light treatment used in this study was not optimum and that under some different intensity or specific wave length, germinative responses would have been equivalent to those obtained with gibberellin treatment.

Summary and Conclusions

Gibberellin applied as a moistening agent in concentrations of 100 to 1000 ppm. overcame dormancy in seeds of bracted plantain, increased rate of germination, and extended the temperature range over which germination occurred. Light and 0.2 percent KNO_3 stimulated germination but complete germination did not occur except at 20°C. and 20-30°C. when they were applied in combination. It is suggested that a simple substitution of gibberellin for light is not involved.

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