Proceedings of the Iowa Academy of Science

Volume 67 | Annual Issue Article 14

1960

Effect of Gibberellic Acid on Oats

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Abstract. Oat plants were sprayed with gibberellic acid in concentrations of 10 ppm, 100 ppm, 1000 ppm, and 2,500 ppm at 24 hours before and 24 and 144 hours after anthesis. The application 24 hours before or after anthesis caused 10 percent to 50 percent elongation of the upper internodes. Weight of the primary kernels was depressed approximately 10 percent and that of the secondary 15 percent. The effect upon seed size was independent of time of application or concentration.

Gibberellic acid applied in low concentrations to growing plants usually stimulates growth (Stodola, 1958). Yabuta and Hayashi (1939) found that the application of gibberellic acid to barley and buckwheat resulted in abnormal stem elongation, and Bukovac and Wittwer (1956) reported that an application of 10 to 20 micrograms of gibberellic acid per plant caused a 50 percent elongation of celery petioles. Wheat plants treated with gibberellic acid by Brian *et al.* (1954) and others (Imperial Chemical Products, 1955) gave increased total dry weight but reduced root dry weight at maturity. When young rice plants were treated with gibberallic acid by Hayashi *et al.* (1953) stem elongation was marked, tillering was decreased, and at maturity grain yield was depressed and straw yield increased.

Since gibberellic acid is known to stimulate growth of the vegetative parts of plants, an experiment was designed to determine whether similar stimulation occurred in oat seeds. Size of oat seedling is related for an interval after germination to the size of the germinating seed (Frey *et al.,* 1958); therefore any increase that might be produced in seed size could result in seedlings with superior vigor which might aid in establishing a vigorous spring seeding.

Materials and Methods

For this study Putnam oats were grown in 1958 and 1959 at the Agronomy Farm at Ames, Iowa, in hills (25 plants per hill) with a 1-foot spacing between the hills. The seeds were planted 1½ inches deep on approximately April 15 in both years. The experimental design was a randomized block with three replicates, and two hills in each replicate received the same treatment.

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[1]Journal Paper No. J-3854 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1176. In cooperation with the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

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In each hill, 10 culms, uniform in stage of development, were marked with tags when the tip spikelet was emerging from the boot. Oat culms, including the heads, were sprayed at 3 stages of development—24 hours before and 24 and 144 hours after anthesis. Four concentrations of gibberellic acid (10 ppm, 100 ppm, 1000 ppm, and 2500 ppm) were used at each stage, giving a total of 13 treatments including the check. The upper 5 spikelets on a head were used to judge when anthesis had occurred. The gibberellic acid source was the 75 percent active sodium salt dissolved in water to which a detergent was added to enhance spreading on the plant tissue surface. Before a hill of oat plants was sprayed, it was enclosed in a celluloid sleeve to keep the gibberellic acid from drifting to adjacent hills. The oat culms were sprayed with a fly sprayer until the gibberellic acid solution dripped off.

At maturity the upper 3 internodes of each culm were measured in inches, and then the heads were cut off and placed in envelopes for future analyses. In some cases the treated plants in a hill had

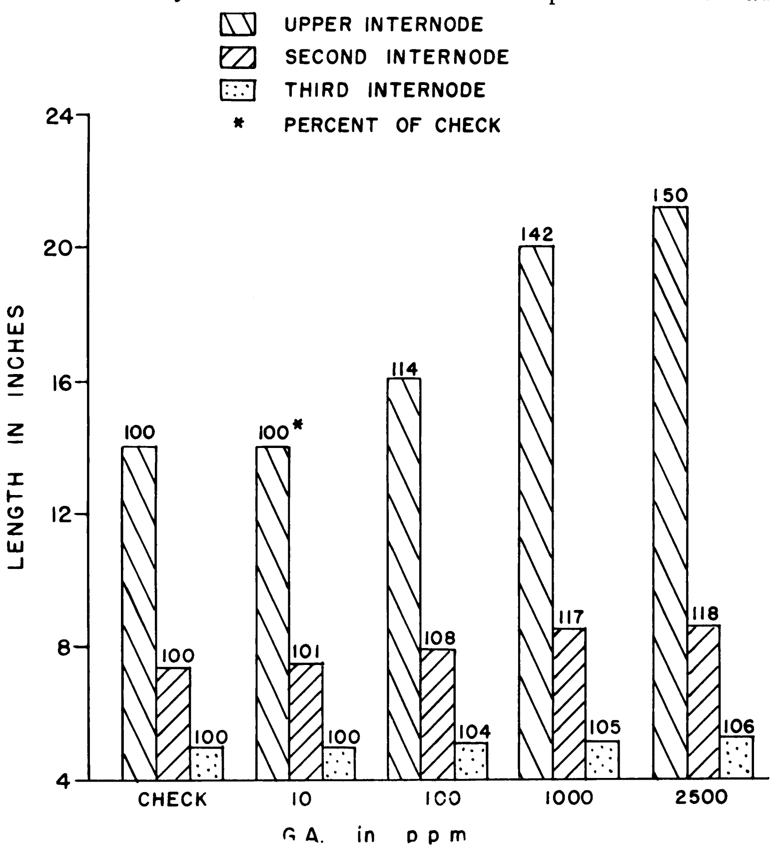

Figure 1. Lengths at maturity of the upper 3 internodes of oat culms sprayed with various concentrations of gibberellic acid 24 hours before anthesis.

to be supported with bamboo stakes to prevent breaking of the stems. Since the percentage increase in internode length resulting from a given treatment was approximately the same in 1958 and 1959, the data from the 2 years have been combined for presentation. For seed-weight determinations, the upper 8 fertile spikelets on the treated heads in a plot were stripped off, threshed, separated into primary and secondary seed classes, and weighed. The weights for each class were adjusted to weight per 100 seeds. Just prior to harvest in 1958, birds shattered much of the grain from the heads of treated plants; so only 1959 seed weights are presented.

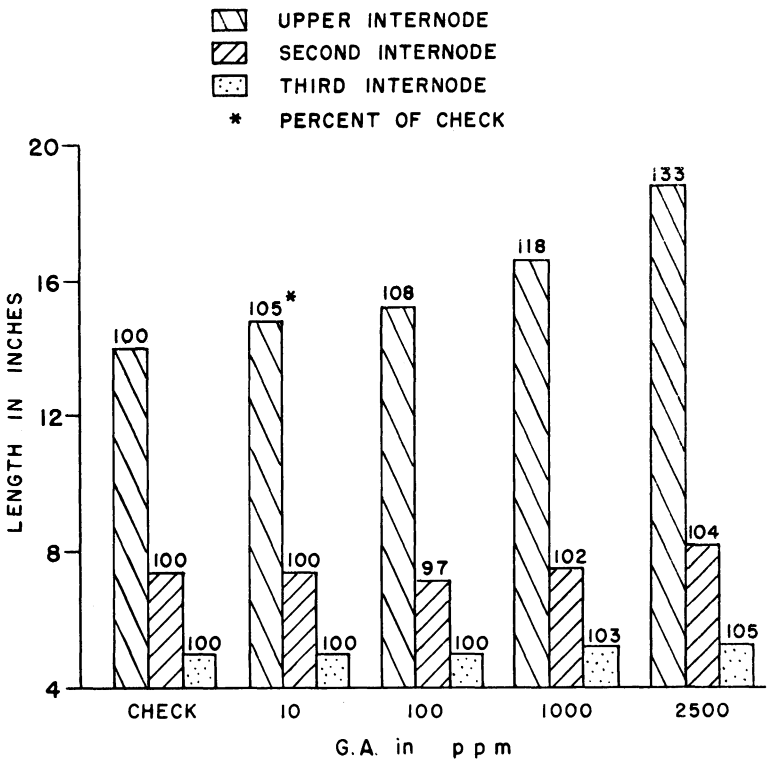

Figure 2. Lengths at maturity of the upper 3 internodes of oat culms sprayed with various concentrations of gibberellic acid 24 hours after anthesis.

Experimental Results

The mean internode lengths from the oat culms sprayed with different concentrations of gibberellic acid 24 hours before and 24 and 144 hours after anthesis are shown in figures 1, 2, and 3, respectively. The upper one was stimulated most by the gibberellic acid treatments, with increases of 50 percent in length with the highest concentration and earliest date of application. Apparently, 24 hours before anthesis the intercallery meristems of the upper 2 internodes were still active. In contrast, no lengthening of the leaf sheath was apparent. There was considerable elongation of the upper internode when the plants were treated 24 hours after anthesis, but when they were sprayed 144 hours after anthesis the gibberellic acid stimulus was negligible. The second internode showed elongation at the earliest date of application, but subsequently there was no appreciable growth stimulation. The third internode was not lengthened appreciably at any of the times of application. The percentage increase in stem elongation was related to the strength of gibberellic acid solution, but the 2500-ppm concentration did not appear to give the maximum stimulation possible.

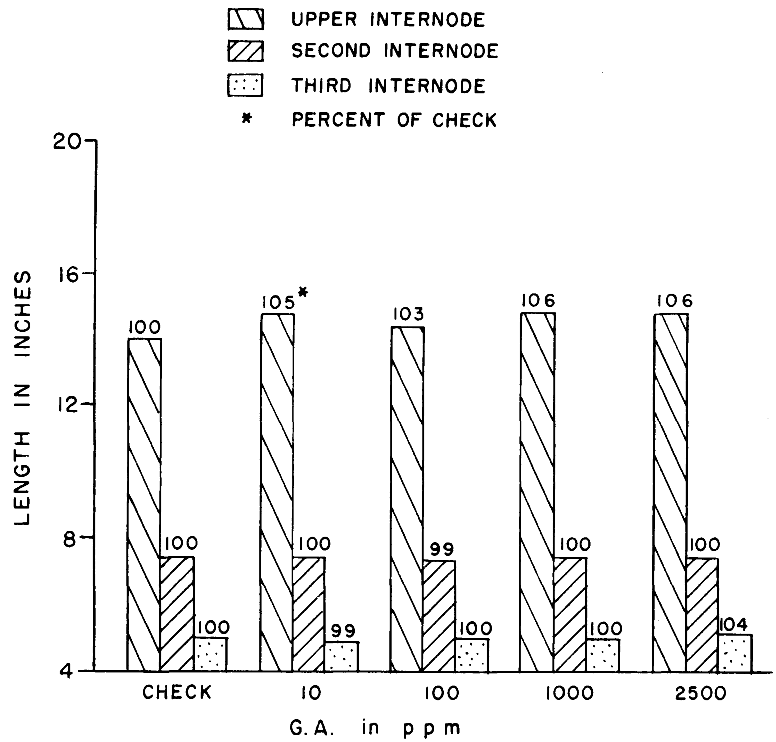

Figure 3. Lengths at maturity of the upper 3 internodes of oat culms sprayed with various concentrations of gibberellic acid 144 hours after anthesis.

The gibberellic acid treatments caused a reduction in weight of 10 percent in primary and of 15 percent in secondary seeds (Figure 4). These results corroborate the work of Hayashi *et al.* (1953), who found that gibberellic acid treatment reduced the grain yield of rice. Neither the concentration of the gibberellic acid nor the stage when applied caused any variability in the magnitude of depression in seed weight. If the seed weight was decreased because more photosynthetic products were required for extra stem growth, the greatest depression in seed weight and the greatest stem elongation should have coincided, i.e., 24 hours before anthesis. Obviously, such was not the case.

The possibility of using gibberellic acid to increase seed size of oats, with all of its practical and theoretical ramifications, was intriguing. However, when the experiment was conducted, a reduction in seed weight resulted which was independent of gibberellic acid concentration or time of application. Furthermore, the elongation

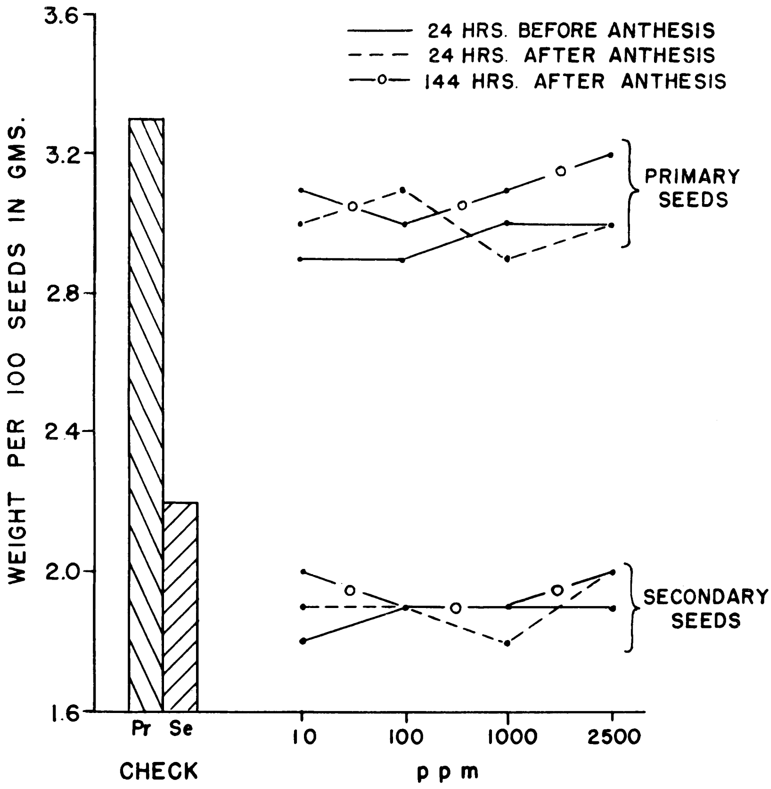

Figure 4. Weights per 100 primary (Pr) and secondary (Se) oat seeds from plants sprayed with various concentrations of gibberellic acid 24 hours before and 24 and 144 hours after anthesis.

of the oat stems would have forestalled any practical use of spraying with gibberellic acid, even if the seed size had been increased.

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