Effect of Gibberellic Acid, 2,4-D, and Indole-Acetic Acid on Seed Germination and Epicotyl and Radicle Growth of Intermediate and Pubescent Wheatgrass

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Improvement of seedling vigor is considered one of the important objectives in most grass breeding programs. Grasses, in general, are slow to establish even under the most ideal environmental conditions. Increased vigor becomes even more important in establishment under the generally adverse environmental conditions of the Northern Great Plains.

Several investigations have indicated that increased seed size within certain species produced more vigorous seedlings. Rogler (1954) indicated a very close relationship between seed size and seedling vigor, as well as a high positive correlation between seed size and emergence of seedlings from deeper seedings with crested wheatgrass. Kneebone (1956) and Kneebone and Cremer (1955), working with some of the native species of the Southern Great Plains, found that the larger seed within a lot emerged faster and grew at a faster rate than smaller seed. These studies also indicate that the potential for improvement of this characteristic is much greater in certain species than in others.

Soil moisture is usually the limiting factor in establishment under dryland conditions, therefore, early and rapid root elongation would appear to be an important factor in overcoming this hazard. Most of the past studies have not taken into consideration the vigor of root elongation. This could also be correlated with seed size. A study of this relationship is now underway at the Wyoming Agricultural Experiment Station. The present studies, however, are concerned with the effect of certain hormone-type chemicals on the rapidity of germination and elongation of both the epicotyl and radicle in grasses.

Literature

Investigations on the effect of 2,4-dichlorophenoxyacetic acid on forage grasses mostly have been concerned with its effect on seed produced on sprayed plants. Bass and Sylwester (1956) indicated that 2,4-D applications on Kentucky bluegrass, when in the boot stage, markedly affected viability of the seed produced. Mitchell and Marth (1945) found that 2,4-D at rates equivalent to ¾, 1½, 2¼ and 3 pounds of the acid per acre sprayed on seeded seedbeds reduced emergence of redtop by 28, 83, 83 and 95 percent respec-

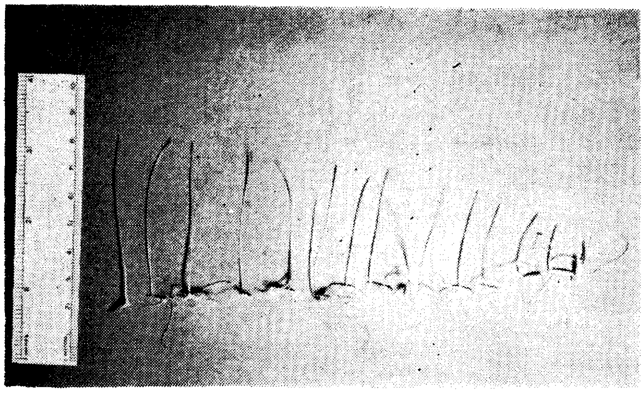

FIGURE 1. Intermediate wheatgrass, check.

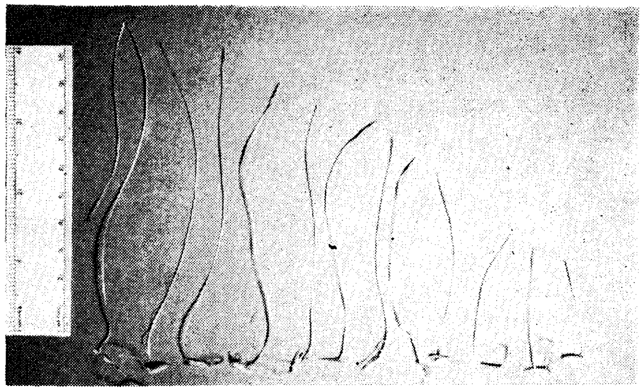

FIGURE 2. Intermediate wheatgrass germinated in a 100 ppm solution of gibberellic acid.

tively. Rates equivalent to ¾ and 1½ pounds of acid per acre increased emergence in red fescue, while heavier applications of 2¼ to 3 pounds per acre reduced emergence by 10 and 17 percent. On soil sprayed at a rate of ¾ pound per acre, a 14 percent increase in emergence of Kentucky bluegrass occurred. The heavier application, however, reduced emergence of bluegrass by as much as 32 percent. A reduction in growth of all species occurred for a short period after emergence. This reduction was of a temporary nature. Marth *et al.* (1948) found that 2,4-D (acid form) sprayed on grasses, even when seed was maturing, had no effect on germination of sound seed produced.

Gibberellic acid, a relatively new growth-promoting chemical has received considerable attention during the past few years. It has been suggested as a possible means of replacing the cold or vernalization requirement for flowering in certain biennials (5). The ability of gibberellic acid in promoting faster and greater growth on many plant species, including grasses, has been demonstrated by various workers in recent years (Leben and Barton, 1957; Wittwer and Bukovac, 1957). Bass, 1957, in studies conducted on the effect of gibberellic acid on germination of Kentucky bluegrass, Merion bluegrass and western wheatgrass, found no increase in total germination or rate of germination. There appeared to be some increase in the rate of elongation of the seedlings from certain concentrations; however, measurements were not made. Whaley and Kephart (1957), working with excised apical segments of both primary and adventitious seminal roots of maize, found that the root growth in certain genotypes of maize is significantly stimulated by gibberellic acid.

Beta-indole-acetic acid has been known for many years for its growth promoting and inhibiting characteristics. The effect of indole-acetic on seedling grasses or grass seed apparently has not been investigated.

Materials and Methods

This study involved the effect of various concentrations of 2,4-dichlorophenoxyacetic acid, Beta-indole-acetic acid, and gibberellic acid on germination and on radicle and epicotyl elongation of intermediate wheatgrass (*Agropyron intermedium*) and pubescent wheatgrass (*Agropyron tricophorun*). The chemical solutions were used as wetting media on germination blotters. Gibberellic acid and Beta-indole-acetic acid were used at concentrations of 50, 100 and 200 ppm.,

Table 1. Effect of gibberellic acid, 2,4-D, and indole-acetic acid on growth of radicle and germination of intermediate and pubescent wheatgrass four days after seeding.

Treatment	Intermediate		Pubescent	
	Mean growth in milli-meters	Germi-nation percent	Mean growth in milli-meters	Germi-nation percent
Gibberellic acid				
200 ppm.	6.98	78.33	6.46	81.67
100 ppm.	7.35	85.00	7.27	81.67
50 ppm.	8.68	76.67	9.32	81.67
Indole-acetic acid				
200 ppm.	1.28	78.33	1.19	55.00
100 ppm.	1.25	65.00	1.29	66.67
50 ppm.	1.29	70.00	1.23	75.00
2,4-D				
10 ppm.	4.93	81.67	6.99	81.67
5 ppm.	6.38	88.33	6.21	85.00
.5 ppm.	8.26	80.00	7.23	86.67
Check	7.45	86.67	7.99	83.33
LSD 0.05	1.60		1.60	

while 2-4-dichlorophenoxyacetic acid was used at .5, 5 and 10 ppm. All chemicals were dissolved in a small quantity of ethyl alcohol along with a few drops of detergent before preparing final dilutions. The same dilution of alcohol and detergent were used in the check treatments to make them comparable to the chemical treatments.

Twenty-five ml. of a given solution was placed in a four inch square germination dish containing three ordinary germination blotters. Twenty seeds of a given species were evenly spaced in each dish. Treatments were replicated three times. Seed was germinated in constant temperature chambers at 20° C. The chambers were lighted for a period of eight hours with sixteen hours of darkness. Measurements of radicle and epicotyl were made on the fourth and twelfth days after seed was placed in the germinators.

Table 2. Effect of gibberellic acid, 2,4-D, and indole-acetic acid on epicotyl, radicle growth and germination of intermediate and pubescent wheatgrass twelve days after seeding.

Treatment	Intermediate			Pubescent		
	Mean epicotyl growth in mm.	Mean radicle growth in mm.	Germination per-cent	Mean epicotyl growth in mm.	Mean radicle growth in mm.	Germination per-cent
Gibberellic acid						
200 ppm.	46.72	28.23	93.33	50.74	40.85	91.67
100 ppm.	73.40	32.34	90.00	54.40	43.10	95.00
50 ppm.	56.31	34.51	86.67	61.46	46.09	96.67
Indole-acetic acid						
200 ppm.	10.73	1.18	91.67	20.97	1.30	86.67
100 ppm.	12.68	1.43	83.33	21.17	1.43	95.00
50 ppm.	18.18	6.39	85.00	19.10	2.11	95.00
2,4-D						
10 ppm.	31.48	8.25	86.67	51.16	16.49	96.67
5 ppm.	49.38	11.25	96.67	55.70	21.19	95.00
.5 ppm.	49.38	24.63	95.00	55.55	41.22	95.00
Check	26.86	32.75	95.00	46.37	47.30	96.67
LSD 0.05	12.91	5.23		12.91	5.23	

Results and Discussion

Results of the measurements of radicle and epicotyl elongation are presented in Tables 1 and 2. On the fourth day no measurable epicotyl growth had taken place. Indole-acetic acid, at all concentrations, reduced radicle elongation significantly below that of any other treatment, including the checks. In both species the seeds germinated in the indole-acetic acid solutions showed no radicle growth, other than a short bud one to two millimeters long. None of the chemical treatments induced radicle elongation significantly greater than that of the checks in either species. Since gibberellic acid at 50 ppm. approached significance over the checks, and since a gradual increase in elongation takes place as concentration decreases, it may indicate that optimum concentration for root elongation had not been reached.

A factor of considerable interest, in both the first and second measurements, was the production of multiple and branched primary radicles at all concentrations of 2,4-D. Measurement in the experiment was made of only the longest single radicle. It is now felt that if total length had been taken into consideration, the 2,4-D treatments would have shown considerably more growth than any other treatment, including the checks. As many as five branched radicles were produced by some of the 2,4-D treatments.

Germination percentage was reduced slightly by all concentrations of indole-acetic acid at the first measurement. This dif-

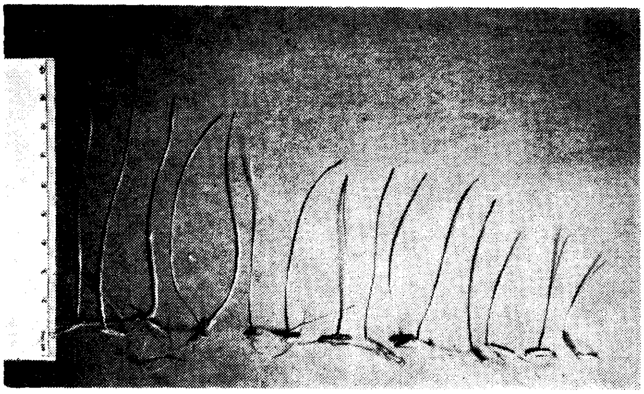

FIGURE 3. Pubescent wheatgrass germinated in a 2,4-D solution at a concentration of 0.5 ppm. Note the multiple radicle on many of the germinated seeds.

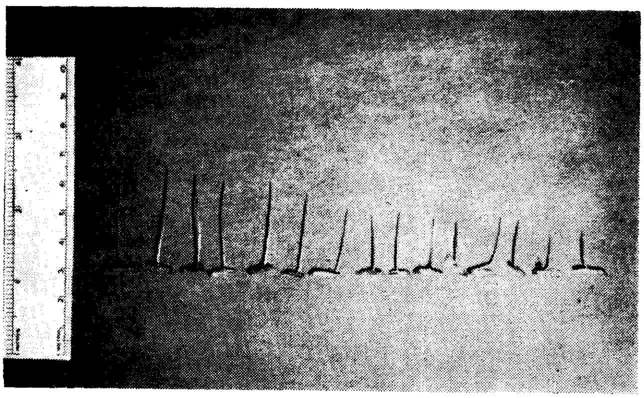

Figure 4. Pubescent wheatgrass germinated in an indole-acetic acid solution at a concentration of 50 ppm. Note that no radicle growth was made.

ference was not evident at the second measurement.

The second measurement, made twelve days after seeding, showed no appreciable increase in length of the radicles of the seed treatments of indole-acetic acid. The average length of the radicle in all three concentrations was two to four millimeters. The epicotyl growth of the indole-acetic acid treatments was significantly less than that of the other treatments, including the checks.

Gibberellic acid decreased radicle elongation only at the highest concentration of 200 ppm. Growth at this concentration was less than either the check or the two lower concentrations in both species.

Epicotyl elongation of intermediate wheatgrass responded differently to gibberellic acid concentration than did pubescent wheatgrass. All concentrations on intermediate gave significantly greater growth than the checks, with 100 ppm. being higher than either 200 or 50 ppm. There was no apparent difference in response of pubescent to the three concentrations. A concentration of 50 ppm. was slightly higher than the check.

2,4-D decreased elongation of the radicle at all concentrations in both species. Epicotyl elongation was increased at all concentrations except 10 ppm. in intermediate wheatgrass. There was no appreciable effect on epicotyl elongation of pubescent wheatgrass.

Germination of either species was not affected by any of the chemicals used.

Summary

The effects of gibberellic acid, 2,4-D, and indole-acetic acid on germination of seed and on radicle and epicotyl growth of intermediate and pubescent wheatgrass were tested.

Germination of the seed of the grasses was not affected by any of the chemicals at the concentrations used.

None of the chemical treatments increased radicle elongation significantly over that of the checks. Indole-acetic at all concentrations reduced radicle elongation. All concentrations of 2,4-D resulted in the production of multiple and branched primary radicles. Gibberellic acid reduced radicle elongation only at the highest concentration used, 200 ppm.

Epicotyl elongation in intermediate wheatgrass was increased by gibberellic acid and 2,4-D and inhibited by indole-acetic. Epicotyl growth in pubescent wheatgrass was not affected by gibberellic acid or 2,4-D, but was inhibited by indole-acetic acid.

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NOTICE

DR. HOMER L. SHANTZ died of a heart attack on June 23, while on a botany field trip near Rapid City, South Dakota. At the time of his death DR. SHANTZ was studying vegetation changes in the Northern Great Plains on a research grant from the Office of Naval Research. This was a re-survey of areas previously studied in the period 1908-1923.

A memorial statement on DR. SHANTZ will be published in a later issue of the Journal.