Root and Shoot Growth Following Preplanting Treatment of Grass Seed[1]

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Highlight

Seeds in the crested wheatgrass complex were placed under favorable germination conditions for periods of 10 to 90 hr, superficially dried and then planted in a greenhouse. Root lengths 3 to 6 days after planting indicated a 1 to 2-day advantage from preplanting treatment. On the basis of present data, near maximum response should result from treatments at 50 to 70F for as much as 40 to 70 hr duration. There was considerable variation in the response of different seed sources.

Leads provided by McKee (1935) and Chippendale (1934) led Keller and Bleak (1968) to demonstrate with *Agropyrons* that seedlings emerge sooner after a partial germination treatment of the seed. "Treated" seeds produced greenhouse seedlings which emerged from a 0.5-inch planting depth in Provo sand about 40 hr ahead of those from non-treated seeds.

In range seeding the early emergence of seedlings is certainly important, but the earliest initiation of root penetration into the soil, under conditions favorable for seedling emergence, may be of greater importance. The present paper reports both root and shoot length of seedlings from both treated and non-treated seeds.

Materials and Methods

Six lots of *Agropyron* seed were used, four large-seeded lots and two small-seeded lots. The large seeded lots were: (1) *A. desertorum* (Fisch. ex Link) Schult. commercial 'Nordan' grown in northern Utah in 1965 (a sub-lot (01) receiving a different preplanting treatment); (2) certified Nordan grown in North Dakota in 1965; (3) induced tetraploid *A. cristatum* (L.) Gaertn. × *A. desertorum* obtained from Dr. D. R. Dewey; and (4) *A. desertorum* 'Summit' F. C. 38332. The small-seeded lots were: (5) *A. cristatum* commercial Fairway F. C. 38561 and (6) Nebraska 3576 Fairway.

Preplanting treatment with tap water involved wetting, but not submerging the seeds in covered boxes placed in constant temperature cabinets for varying periods of time. In each study treatments were all scheduled to end on the same morning. Following treatment, seeds were superficially dried by exposure for 2 min to a warm air blast except lot 01 which was planted without drying. The treated seeds to be planted were wrapped in aluminum foil to prevent further dehydration. Planting was completed the same afternoon. The soil was kept moist at all times.

To measure root and shoot length, a section of soil

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Table 1. Mean root and shoot length in mm, average of 8 treatment durations 20 to 90 hr, inclusive, vs. controls, 6 and 7 days after planting.

Item	Treatment Temp. F	Days After Planting 6 Treated	6 Control	6 Gain	7 Treated	7 Control	7 Gain
Roots	40	55.8	50.3	5.5	70.7	61.5	9.2
	63	63.8		13.0	74.6		13.1
	82	63.5		13.2	72.8		11.3
Shoots	40	38.8	30.7	8.1	47.4	40.0	7.4
	63	45.1		14.4	51.0		11.0
	82	40.8		10.1	50.8		10.8

containing the roots was removed from the greenhouse bench, laid horizontally on an ⅛-inch mesh wire screen and sprayed with water under low pressure until the sand was washed from the roots. All measurements were in millimeters.

In the first study seeds of commercial Nordan (No. 1 above) were held at 40, 63 and 82F for intervals varying from 10 to 90 hr in 10-hr increments. Fifty seeds were planted per row in 3 replications. Four rows, located at random, in each replication, were planted to 50 untreated seeds to provide a control by which to evaluate the treatments. One replication was dug for root and shoot measurements on each of 2 successive days, the 6th and 7th after planting. We chose every 3rd plant until 10 had been measured.

In the second study all 6 seed sources were used. Treatment was at 63F only, with time at 10-hr increments from 40–90 hr. Twenty-five seeds were planted in each row, in 4 replications. In each replication one row of untreated seed of each seed source was planted as a control. One replication was dug for root and shoot measurements on each of 4 successive days, the 3rd to 6th after planting. From each harvested row we measured the 10 longest rooted plants.

Results

First Study

Treatment at 63 or 82F resulted in roots and shoots at least 10 mm longer than controls on both harvest days. Seeds treated at 40F yielded roots and shoots approximately intermediate between controls and those from treatment at 63 or 82F.

Rather marked differences in seedling emergence were associated with different treatment durations (Keller and Bleak, 1968), particularly at 63F and at the first counting date, 3rd day after planting. However, by the first root and shoot measuring date, 6 days after planting, treatments for 20 through 90 hr yielded no significant differences. Only the control plants and those from the 10-hr seed treatment had roots and shoots shorter than the others. The average response in root and shoot length, following preplanting treatments from 20 through 90 hr and controls, is presented in Table 1. At both 40 and 63F the longer treatment time gave longer roots and shoots than the shorter treatment time while at 82F shoots were no different and roots averaged longer from the shorter treatments.

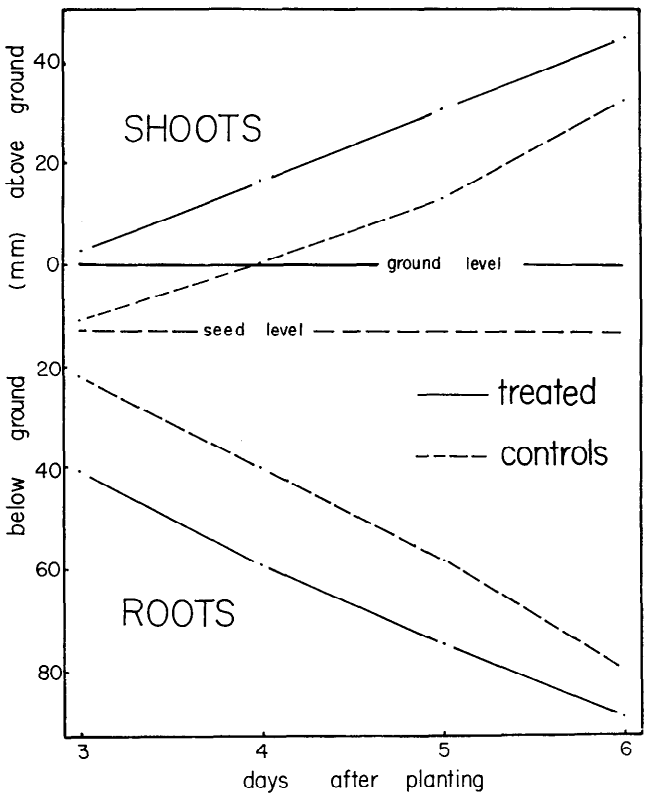

FIG. 1. Average root and shoot length for the four large-seeded *Agropyrons* 3 to 6 days after planting.

The data in Table 1 were examined before averaging treatment durations. At 82F treatments lasting 10 to 40 hr produced the longest roots and shoots. In contrast, at either 40 or 63F the longest roots and shoots were from 50 to 90-hr treatments. Treatment at 63F initiated root growth in less time than treatment at 40F. These data are in agreement with many biological reactions in which, within limits, activity is hastened by an increase in temperature.

From the first study we conclude that root and shoot growth would probably be initiated in the least time by treatments lasting 50 to 90 hr at 63F. A fuller analysis of these data does not seem justified because measuring every third plant was not the best method of demonstrating the effectiveness of the preplanting treatment. In addition, since emergence was good by the 4th day, our measurements of root and shoot length should have been made 2 or 3 days earlier.

Second Study

Root and shoot length for the four large seeded *Agropyrons* on four successive days is presented

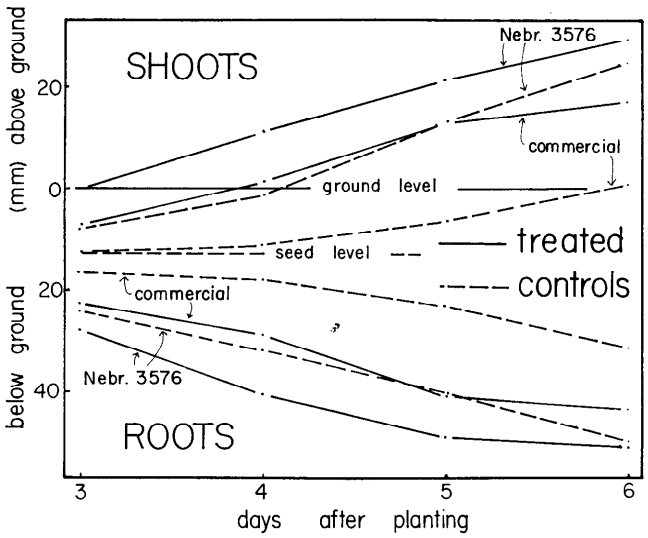

FIG. 2. Root and shoot length of the two small-seeded *Agropyrons* 3 to 6 days after planting.

in Fig. 1. The depth to which roots are assumed to have penetrated is indicated by the length of measured roots added to the depth of seeding, while the length of shoots begins at the seeding depth and not at the soil surface. Each point for treated seeds is an average of four accessions at each of six treatment durations ranging from 40 to 90 hr, inclusive. Each point for controls is an average of the four accessions. Seedlings from treated seeds harvested 3, 4 or 5 days after planting had roots averaging 19 mm longer, and shoots averaging 15 mm longer than those from untreated seeds. In each case, by the 6th day after planting, the difference was markedly reduced. During the first 3 harvest days, 19 mm root growth gave the treated a little more than 1 day's advantage over untreated. Both grew an average of 16 mm/day. Roots from treated seeds had reached an average depth of 88 mm on the 4th harvest day. Shoot growth averaged 14 mm per day during the same period.

Root and shoot length for the two Fairway strains are presented in Fig. 2. They are too different to be averaged. Root and shoot growth of Nebraska 3576 were each about 1 day ahead of the commercial source. Treated Nebraska 3576 was about 1 day ahead of the control. Treated commercial and the control for Nebraska 3576 were each 2 days ahead of untreated commercial. The latter had barely emerged the 4th day of harvest. The 10 longest roots of untreated commercial had reached an average depth of only 32 mm, while treated Nebraska 3576 had reached 51 mm the 4th harvest day, 6 days after planting.

A comparison of root and shoot length from treated seeds that were superficially dried before planting vs treated seeds that were not dried before planting is presented in Fig. 3. Drying had a small but consistent effect in delaying start of root growth. Roots from controls required 40 additional hr to reach the length attained by treated and dried seeds on the first harvest date, the 3rd day after planting, and 46 hr to reach the length attained by roots from treated but not dried seeds. Three days after planting shoot length from treated and dried seeds was 39 hr ahead, and from treated but not dried seeds 46 hr ahead of those

Table 2. Root length in mm for six seed lots of *Agropyrons* 3 to 6 days after planting when given preplanting treatments of 40 to 90 hr (averaged) and controls.

Seed Lot[1]	Days After Seeding 3 Treated	3 Control	4 Treated	4 Control	5 Treated	5 Control	6 Treated	6 Control	Four-day mean gain from treatment
01[2]	32.2a[3]		51.5a		62.9bc		78.9b		30.0
1	26.4a	1.0	46.1a	19.4	56.8cd	31.8	77.0b	53.5	25.2
2	26.6a	5.0	41.6a	24.9	52.3d	45.0	65.1c	68.9	11.0
3	29.4a	15.5	49.3a	36.2	72.5a	58.8	89.2a	61.8	17.0
4	27.1a	13.4	47.6a	27.6	66.4ab	43.9	75.6b	84.2	11.9
Treatment gain									
1–4	18.7		19.2		17.2		9.6		16.2
5	9.3b	4.0	15.6c	4.9	28.1e	9.8	30.4e	18.4	11.5
6	15.0b	11.2	27.6b	18.9	35.8e	27.1	38.0d	37.2	5.5
Treatment gain									
5–6	4.5		9.7		13.5		6.4		8.5

[1] (1 and 01) *A. desertorum* commercial Nordan grown in Northern Utah in 1965; (2) certified Nordan grown in North Dakota in 1965; (3) induced tetrapoloid *A. cristatum* × *A. desertorum* obtained from D. R. Dewey; (4) *A. desertorum* 'Summit' F. C. 38332; (5) *A. cristatum* commercial fairway F. C. 38561 and (6) Nebraska 3576 fairway.

[2] 01 was not superficially dried following treatment.

[3] Within each column different letters identify significant differences (5%) by Duncan's test.

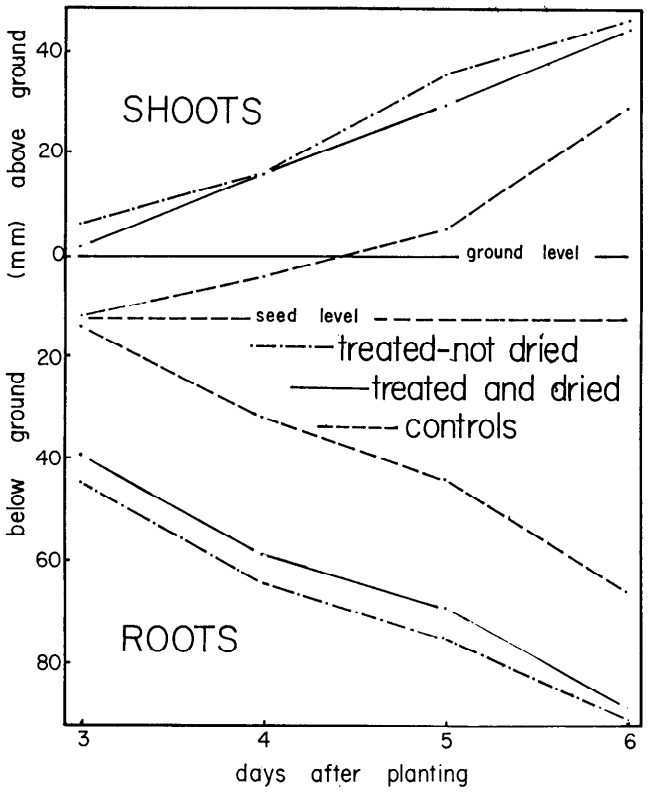

FIG. 3. Root and shoot length of Nordan crested wheatgrass from seed grown in northern Utah, 3 to 6 days after planting.

from controls. Nordan grown in northern Utah gave a greater response to treatment than Nordan from North Dakota, the induced tetraploid or Summit with which it was averaged in Fig. 1. But untreated seeds of this Nordan also had the shortest roots of the four accessions. All of the data for root length from which Figures 1 to 3 are constructed are presented in Table 2. These data reveal that at the first harvest date there were no significant differences among the treated seeds of the large seeded lots (1 to 4, inclusive). These differences developed during the following 3 days. The Fairway lots (5 and 6) were clearly slower to initiate root and shoot growth. When the treatment durations are considered separately, and the 6 seed sources averaged (Table 3), it becomes apparent that there were no significant differences between treatments ranging from 40 to 70 hr inclusive. After the first harvest day, 80 and 90-hr treatments generally had shorter roots. The controls were shorter at each harvest date.

Table 3. Root length in mm 3 to 6 days after seeding in response to seed pre-treatments ranging from 40 to 90 hr, and controls. Each value is an average of 6 seed lots of *Agropyron*.

Hours treatment	Days After Planting 3	4	5	6	4-day mean
0	8.4b[1]	22.0d	36.1c	54.0b	30.1c
40	23.2a	43.9ab	55.2ab	68.8a	47.5a
50	25.8a	46.4a	58.5a	67.7a	49.6a
60	23.5a	43.9a	50.3ab	68.4a	46.5a
70	24.9a	40.3ab	58.8a	69.4a	48.4a
80	23.0a	35.6bc	47.0b	58.7b	41.1b
90	22.0a	32.3c	51.3ab	56.4b	40.5b
Mean	21.5	37.6	51.0	63.4	43.4

[1] Within each column different letters identify significant differences (5%) by Duncan's test.

Discussion and Conclusions

Data obtained up to this time suggest that there is no specific best treatment duration. The range from 40 to 70 hr yielded no significant differences. Likewise, although 63F gave longer roots and shoots than either 40 or 82F, it is likely that good results would be obtained from treatments over a range of from about 50 to 70F or possibly wider.

The data suggest that single seeds within a source differ in response to preplanting seed treatment. Some will be overtreated at a temperature and duration that will leave other seeds undertreated, as expressed in time to emergence and length of roots and shoots. A highly critical time and temperature for treatment may, therefore, have little significance. The data indicate conclusively that shoots emerge, and roots penetrate the soil in less time following preplanting treatment.

During the critical period of germination and initial root and shoot elongation, moisture near the soil surface may be rapidly depleted by high soil temperatures and dry air. Roots from treated seeds remained nearly 1 inch longer for 3 days after seedling emergence. This advantage may under some conditions represent the difference between success and failure in range seeding.

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