Some Effects Of 2,4-D On Turfgrass Seedlings

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The effectiveness of 2,4-D for control of many species of weeds in established turf is widely recognized. Differences in tolerance of the various grasses to the chemical are understood, and in most cases satisfactory treatment procedures have been developed.

However, only very limited information is available on the 2,4-D toxicity to grasses in the seedling stage. Since weeds frequently may develop faster than the grass seedlings they become a serious problem in new seedings. Satisfactory control methods are contingent upon a knowledge of grass seedling tolerance to 2,4-D at different stages of maturity under various treatment rates and environmental conditions.

Field and greenhouse studies recently completed at the Pennsylvania Agricultural Experiment Station have shown that there are significant differences in the tolerance of seedlings of Kentucky bluegrass, creeping red fescue and colonial bentgrass to 2,4-D. Where seedling injury occurred, the plants were weakened and discolored. Those injured most severely eventually died, thus resulting in pronounced reduction in turf density. The results of the study showed, also, that the degree and persistence of injury was affected by the age of the seedlings, the rate of herbicide application, the period when treated and the extent to which there was root absorption of the toxicant.

Field Experiment

The diethanolamine salt of 2,4-D was applied to seedlings of the three species at rates of one-half and one pound actual toxicant per acre. Treatments were made in 1957 on spring (early May), summer (late June) and fall (late August) seedings when the seedlings were 2, 4, 6, 8 and 10 weeks old. Applications were made with a small experimental sprayer, designed to obtain uniform coverage with small volumes of solution. Effects of the treatments were measured by turf density determinations, using the modified point quadrat method, made six weeks after each of the treatments on the spring and summer seedings and in the spring following the fall treatments.

Differences in turf density due to treatments were recorded as percentages of the density of untreated control plots. The plus or minus percentage differences in stand density between the treated and untreated turf are shown in Tables A, B and C.

It will be noted that both rates of treatment caused serious reductions in density of the two-week-old turf of all three species at all treatment periods. Treatments of the four week old turf showed serious injury to the bent, somewhat less to the fescue, and very little to the Kentucky bluegrass. At six weeks of age treatments were still causing material reductions in the density of the bent turf. Fescue seedlings of the same age showed appreciably less injury, while the differences on the Kentucky bluegrass were so slight as to be negligible. Treatments of 8 and 10-week-old turf showed significant injury only to the bent when applied in the fall at the heavier rate. This supports several reports of observations that bentgrass suffers more permanent injury from fall treatments of 2,4-D than at other periods.

A comparison of the effects of the treatments of the spring, summer and fall seeded turf shows that the injury to the fescue and bluegrass was much more severe from the spring and summer applications than in the fall. The fact that significant differences in density of the bent were still in evidence in the spring following the fall treatments at all seedling ages indicates more serious injury at this treatment period. This is further supported by the very low differences recorded for the 8 and 10-week-old plants receiving the spring and summer treatments.

The only conclusion that can be drawn from a comparison of the effects of the one-half and one pound treatment rates

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Table A Percentage variation in turf density of treated over untreated controls for spring, summer, and fall seeded colonial bentgrass at various intervals after emergence.

Age When Treated	a. Rates 1	Spring (Lbs. per Acre) ½	b. Rates 1	Summer (Lbs. per Acre) ½	c. Rates 1	Fall (Lbs. Per Acre) ½
2 wks.	—48*	—52*	—45*	—50*	—13*	—15*
4 wks.	—34	—39*	—35*	—33*	—28*	—11*
6 wks.	—27	—27	—20*	— 8	—24*	—21*
8 wks.	— 8	—18	— 8	— 4	—17*	—13*
10 wks.	— 1	+ 2	+ 2	+1	—11*	— 7

* Significant at the 5% level

Table B. Percentage variation in turf density of treated over untreated controls for spring, summer, and fall seeded creeping red fescue at various intervals after emergence.

Age When Treated	a. Rates 1	Spring (Lbs. per Acre) ½	b. Rates 1	Summer (Lbs. per Acre) ½	c. Rates 1	Fall (Lbs. Per Acre) ½
2 wks.	—40*	—21	—43*	—30*	— 7	— 3
4 wks.	—61*	—51*	—31*	— 8	— 9	0
6 wks.	—11	— 4	—18	+ 1	—14	—13
8 wks.	+ 2	— 6	—14	— 9	— 6	— 3
10 wks.	— 5	0	— 7	+ 3	+ 3	— 6

* Significant at the 5% level.

Table C. Percentage variation in turf density of treated over untreated controls for spring, summer, and fall seeded Kentucky bluegrass at various intervals after emergence.

Age When Treated	a. Rates 1	Spring (Lbs. per Acre) ½	b. Rates 1	Summer (Lbs. per Acre) ½	c. Rates 1	Fall (Lbs. Per Acre) ½
2 wks.	—39*	—23*	—36*	—38*	— 6	— 2
4 wks.	—19*	+ 3	— 9	—14	—16*	—13
6 wks.	— 3	— 9	— 3	— 8	— 5	— 3
8 wks.	— 5	—21	— 4	+ 3	— 1	— 8
10 wks.	+ 5	— 2	—10	— 7	— 8	— 7

* Significant at the 5% level

is that injury to susceptible plants is just about as likely to occur at the lower as at the higher rate. If this is true, its practical importance is that it is not possible to avoid injury to seedling grass from early treatments by reducing treatment rates.

It is recognized that the results of this experiment, conducted at a specific location, cannot be applied directly to areas with materially different environmental conditions. The principal over-all value of the work is that it indicates that there are material differences in seedling resistance to 2,4-D among the grasses and that this will vary depending on the age of the plants and the period when the treatments are made. Since soil moisture was maintained at levels sufficient to insure normal growth and temperatures throughout the test period were of the moderate type normally occurring in this section, the results probably indicate the safe minimum periods following seedling emergence for 2,4-D treatments of the various grasses.

Greenhouse Experiment

It is generally accepted that 2,4-D incorporated in the soil prior to seeding may materially affect germination and seedling development. This immediately raises the question of whether a sufficient quantity of the chemical will get into the soil, when applied as a surface spray to seedling turf, to cause injury. A greenhouse experiment was established in the spring of 1958 to study this possibility.

Kentucky bluegrass was seeded in prepared soil firmed uniformly into glass-front frames under a surface mulch of approximately one-half inch of permalite. The frames were constructed so that they inclined at a 30° angle. This permitted observation and measurement of root and rhizome development through the glass front. Following seedling emergence the stand in each frame was thinned to 4 equally spaced plants.

Prior to 2,4-D treatments the frames were divided into two equal groups of 18 each. The permalite was vacuumed off the one group before each differential treatment and left intact on the other. Treatments with the diethanolamine salt of 2,4-D were applied uniformly to both groups of frames at rates of one-half and one and one-quarter pounds of actual toxicant per acre at 15, 30 and 45 days after seedling emergence. Immediately following each treatment the permalite mulch was vacuumed off the mulched series to prevent leaching of 2,4-D into the soil. All frames were then remulched with fresh permalite.

The effects of the 2,4-D treatments were measured by observational ratings of top growth injury at 2 and 8 weeks following application, by root counts made through the glass fronts of the frames and by determination of tiller numbers and dry weights of tops, rhizomes and roots at the end of the experiment.

The observational ratings of top growth injury resulting from the various treatments are shown in Table D.

Table D Top growth injury ratings of mulched and non-mulched Kentucky bluegrass treated with two rates of 2,4-D when 15, 30, and 45 days old.

Age When Treated (Days)	2,4-D Rate Lbs.	Mulching Treatment	Weeks After Treatment 2	8
15	½	½ inch	Slight	None
15	½	None	Moderate	Moderate
15	1¼	½ inch	Moderate	None
15	1¼	None	Severe	Slight
30	½	½ inch	Moderate	None
30	½	None	Moderately Severe	Slight
30	1¼	½ inch	Moderate	None
30	1¼	None	Moderately Severe	Slight
45	½	½ inch	Slight	None
45	½	None	Moderate	None
45	1¼	½ inch	Slight	None
45	1¼	None	Moderate	Slight

These results conform, in general, with those obtained from field treatments of Kentucky bluegrass. Plant injury decreased materially as the age of the plants, at time of treatment, increased. It is of interest, also, that more severe injury occurred on the unmulched frames. This suggests that root absorption of 2,4-D was at least partially responsible for the more severe damage.

This observation is further substantiated by the root growth data shown in Table E.

Table E Relative root growth of Kentucky bluegrass six weeks after treatment as influenced by 2,4-D treatments of mulched and unmulched plants.

2, 4-D Rate Lbs.	Mulching Treatment	Root number percentages of plants treated at various times after emergence 15 Days	30 Days	45 Days
½	½ inch	75*	78*	84
½	None	52*	63*	91
1¼	½ inch	64*	75*	96
1¼	None	49*	56*	83
Check		100	155	100

* Significant at the 5% level

The results show significantly greater injury to root development at the 15 and 30 day treatment periods on the unmulched frames than on the mulched. Here, again, injury was less severe on the older plants.

The effect of treatments on tillering and weights of tops, rhizomes and roots are given in Table F. This data was taken at the end of the experiment when plants were approximately 4 months old. A comparison of tiller numbers and weight of tops of the treated plants with the controls shows that the treatments did not permanently affect these portions of the plants. On the other hand there was a very significant reduction in rhizome development. This was particularly severe on the unmulched frames, and again suggests that root absorption of the chemical is an important factor in the treatment of seedling grass.

Table F. Average tiller numbers and dry weights[1] of tops, rhizomes, and roots fourteen weeks after emergence of Kentucky bluegrass treated and untreated with 1¼ lbs. of 2,4-D when 15, 30, and 45 days old.

Age When Treated	Mulching Treatment	Tiller Numbers	Weight of Tops	Weight of Rhizomes	Weight of Roots
15	½ inch	157	17.2	6.5*	5.4
15	None	145	14.8	1.8*	2.8*
30	½ inch	168	19.6	6.1*	6.3
30	None	169	21.3	3.1*	5.8
45	½ inch	172	21.8	4.5*	7.1
45	None	193	21.1	2.6*	6.1
Check		167	21.0	8.5	6.2

[1] Weight expressed in grams
* Significant at the 5% level
(Note: No consistent significant difference between the ½ lb. and 1¼ lb. rate.)

The results of the greenhouse study strongly suggest that turf density must be taken into consideration when making practical applications of 2,4-D to seedling grasses. The significantly greater injury to both tops and rhizomes from early treatments of unmulched plants apparently was due to penetration of larger quantities of the chemical into the soil with proportionally greater root absorption. Where sparse stands are treated, it is reasonable to expect that larger quantities of the solution would be washed into the soil than where density is high and more is held on the foliage. When planning to treat thin stands, therefore, it would seem wise to delay applications until plants are at least two to three weeks older than the field experiments indicated would be a safe age at greater densities.

SEED BANK

The United States Department of Agriculture has established a seed repository at Ft. Collins, Colo., for the purpose of preserving seed stocks for the use of plant breeders and research specialists.

1. Only seed will be accepted for storage, because other types of plant material would create exceptional difficulties.
2. All seed accepted becomes Federal property and will be made available to qualified research workers without cost.
3. The criterion of seed stocks accepted will be their value as basic germ plasm for future use and comparison. Each shall be fully documented as to source and development history. A major consideration in acceptance will be proper and full records.
4. Any bonafide research worker of the United States or its territories and possessions may receive laboratory seed if it is not available elsewhere.
5. The laboratory will arrange for rejuvenation of seed stocks when loss of viability becomes serious or when stocks need replenishment.