Effect of Fertilizer Slurries Used With Hydro-Seeding on Seed Viability

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•THE APPLICATION of seeds in water in any combination with fertilizer or wood-fiber cellulose mulch for establishing turf is called hydro-seeding. This is a labor-saving technique because the seed and fertilizer or seed, fertilizer, and mulch may be applied in one operation. The method is especially suitable for making turf seedings on slopes where other mechanical methods cannot be used. Hydro-seeding methods have been employed by highway departments and seeding contractors on roadsides, industrial sites, parks, lawns, golf courses, athletic fields and other areas for establishing turf. This method is also very suitable for simultaneous reseeding, refertilizing and mulching degenerated slopes (1). This paper gives results on the effect of seed viability and germination as influenced by length of exposure and concentration of fertilizer solutions.

PROCEDURE

Experiment I

Seeds of the following species were used: Ky. 31 tall fescue (Festuca elatior arundinacea), redtop (Agrostis alba), oats (Avena sativa, var. Forkedeer), rye (Secale cereale, var. Abruzzi), millet (Setaria italica, var. Hungarian), red clover (Trifolium pratense), white clover (Trifolium repens), and perennial ryegrass (Lolium perenne). Seeds were exposed to different concentrations of fertilizer slurries for different lengths of time (Table 1). A 12-12-12 commercial fertilizer was used with all concentrations and exposures.

Germination tests of the seeds were made on moist blotters in two ways: (a) immediately after seed removal from slurries, and (b) removal from slurries, dried and then germinated. Seeds that were not soaked in slurries were used as controls. One hundred seeds were used for the germination test for each treatment. The trials were conducted twice to serve as replications.

Experiment II

This experiment was conducted to study germination as interrelated to soil moisture and fertilization. A sandy loam subsoil was used. The amount of moisture at field capacity was 20 percent and the permanent wilting percentage of the soil, as determined by the pressure membrane method was 11 percent (2). The soil was placed in shallow pans where it was equilibrated to supply different amounts of available moisture. Total soil moisture treatments of 12, 14, and 20 percent supplied 1, 3, and 9 percent of available moisture, respectively.

Abruzzi rye was soaked in a water-seed-fertilizer slurry for 30 min. This slurry, equivalent to 1,000 lb per acre of a 10-20-10, was applied on the soil surface to simulate hydro-seeding. Rye was also seeded dry with fertilizer, dry without fertilizer, and with distilled water equivalent to the water in the slurry treatment. These

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seed treatments were used with the three moisture levels already mentioned. The shallow pans with soil were placed in a controlled temperature germinator.

Each treatment was replicated three times and there were 100 seeds per treatment. The seeds were pressed down to contact the soil, but they were not covered. All treatments received equal amounts of water, but the small amount added did not change the available soil moisture.

Dry Kentucky 31 fescue was placed on the soil surface, with and without fertilizer, to study germination under the 3 levels of available moisture.

TABLE 1

GERMINATION OF ABRUZZI RYE AND KENTUCKY 31 FESCUE AS INFLUENCED BY SOAKING TIME AND FERTILIZER CONCENTRATION

Fertilizer Concentration	Exposure Time	Germination (%)			
		Abruzzi Rye		Ky. 31 Fescue	
		Actual	Relative	Actual	Relative
Control		57a[1]	100	98a[1]	100
350 lb/750 gal water	15 min	48b	84	87a, b	89
350 lb/750 gal water	30 min	45b	79	86a, b	88
350 lb/750 gal water	1 hr	35c	62	89a, b	91
350 lb/750 gal water	4 hr	31c	54	70c	71
350 lb/750 gal water	8 hr	23d	40	79b, c	81
700 lb/750 gal water	30 min	30c	53	61c	62

[1]Germination values with same letters are not significantly different at 5 percent level.

RESULTS AND DISCUSSION

Experiment I

The germination of rye was injured by soaking seed with a water-fertilizer slurry (Table 1). The germination of unsoaked seed was 100 as compared with relative values of 79 to 84 when the seed was soaked for 15 to 30 min. Soaking the seed for 8 hr reduced germination to a relative value of only 40 percent. Increasing the fertilizer concentration from 350 to 700 lb of fertilizer per 750 gal of water caused a significant reduction in germination of rye.

Kentucky 31 fescue seed soaked in a slurry (equivalent to 350 lb of fertilizer in 750 gal of water) for as long as 60 min did not reduce germination (Table 1). The soaking of seed for 4 to 8 hr in a slurry, however, did reduce germination as compared with unsoaked seed. Doubling the concentration of the slurry was found to injure the germination of tall fescue seed.

The combined average germination of seed from six species (redtop, perennial ryegrass, red clover, white clover, millet, and oats) shows that germination was not injured by the less concentrated fertilizer slurries (Table 2). Exposing the seed for as long as 8 hr to the less concentrated water-fertilizer slurry did not injure germination. Germination values for seeds germinated immediately after soaking and for seeds dried after soaking in a slurry and then germinated were similar, except for the concentrated slurry where higher germination occurred with the latter method. This lower germination with the wet as compared with the dry method may be attributed to concentration of fertilizer salts in the seed environment during germination. Fertilizer salts apparently became separated from the seeds during drying. The results indicate that the soaking effect in concentrated fertilizers per se was not harmful.

The reduced germination of rye as compared with other seeds exposed to fertilizer-water slurries may be attributed to: (a) rye seed coats may be permeable to specific toxic ions, (b) rye may be susceptible to toxicity of certain ions, and (c) the embryo in rye may be more susceptible to plasmolysis or corrosive action of fertilizer salts than the embryo of other species listed.

Experiment II

Soil moisture, ranging from 1 to 9 percent available moisture, did not influence germination of rye (Table 3). The results were consistent for all seed-water-fertilizer treatments. Soaking the seed in distilled water gave an average germination of 83 percent as compared with 84 percent without soaking. Soaking rye seed for 30 min in a water-fertilizer slurry caused a drastic reduction in germination. Dry seed without fertilizer placed on the soil surface germinated 84 percent as compared with 72 percent where fertilizer was also placed on the soil surface. Rye, as for experiment I, was seriously injured when soaked with a fertilizer slurry, but the fertilizer per se after seeding also reduced germination.

TABLE 2

COMBINED AVERAGE GERMINATION PERCENT OF SIX SPECIES (REDTOP, RED CLOVER, WHITE CLOVER, PERENNIAL RYEGRASS, OATS, AND MILLET) AS INFLUENCED BY SOAKING TIME AND FERTILIZER CONCENTRATION

Fertilizer Concentration	Exposure Time	Wet	Dry
0	0	94	94
350 lb/750 gal water	15 min	90	96
350 lb/750 gal water	30 min	93	92
350 lb/750 gal water	1 hr	91	94
350 lb/750 gal water	4 hr	94	90
350 lb/750 gal water	8 hr	95	86
700 lb/750 gal water	30 min	77[1]	91

[1]Significantly lower than other mean values.

The germination of Kentucky 31 fescue in the absence of fertilizer averaged 62 percent for 1 percent of available soil moisture as compared with 67 percent for field capacity or 9 percent available soil moisture (Table 4). These values did not differ significantly. Conversely, when a 10-20-10 fertilizer at the rate of 1,000 lb per acre was applied on the soil surface with the seed, the germination increased as soil moisture increased. Germination averaged 12, 26, and 50 percent for 1, 3, and 9 percent available moisture, respectively. Sixty-two percent of the seeds germinated in the absence of fertilizer as compared with only 12 percent germination in the presence of fertilizer when 1 percent moisture was available. On the other hand, when available moisture was high, germination averaged 67 percent in the absence of fertilizer as compared with 50 percent when fertilizer and seed were in contact on the soil surface. These results show that fertilizer in contact with Kentucky 31 fescue seed causes a moisture stress at low available versus high available soil moisture.

APPLICATION TO HYDRO-SEEDING

Seeds are normally in contact with a water-fertilizer slurry in tanks of hydro-seeders for less than 20 min before making the applications. This brief contact would not cause a significant injury to germination of the perennial grasses and legumes such as Kentucky 31 fescue, redtop, perennial ryegrass, red clover, and white clover. Other work with bluegrass shows that it is not injured by fertilizer slurries. Likewise, the fertilizer slurry did not perceptibly injure annuals such as oats and millet, but the injury to cereal rye germination was severe for lengthy contacts with fertilizer slurries. The germination injury to rye was low for a short period of exposure.

During normal operations of hydro-seeders, the slight injury to germination that may occur with seeds of some species would not be responsible for seedling failures. The germination injury from a fertilizer slurry reported for rye would not cause seeding failure. The high seeding rates that are used for turf areas as an insurance for success more than compensates for germination injuries to species that may be injured by fertilizer slurry. In other experiments not reported here rye used as a companion grass in a fertilizer slurry with hydro-seeding has given good stands.

Fertilizers are used liberally for establishing turfgrasses because of the low inherent fertility of many soils and also because of the need of establishing stands quickly to control water and soil erosion. Excessively high rates of fertilizers whether applied by the hydro-seeding or other methods retard germination under moisture stress; soluble salts in the fertilizers inhibit moisture

TABLE 3

PERCENT GERMINATION OF ABRUZZI RYE AS INFLUENCED BY SOIL MOISTURE AND FERTILIZER TREATMENTS

Application to Soil Surface (1,000 lb/acre of a 10-20-10 as indicated)	Total Soil Moisture %			Average Germination for Fertilizer Treatments
	12	14	20	
	Available Soil Moisture %			
	1	3	9	
A. Seed-water-fertilizer slurry after soaking for 30 min	52a[1]	45a	44a	47a
B. Seed with water after soaking for 30 min	80c	83c	87c	83c
C. Dry seed and fertilizer[2]	70b	74b	73b	72b
D. Dry seed without fertilizer[2]	83c	84c	86c	84c
Average for 3 moisture levels	71	72	73	

[1]Values with different letters differ significantly.
[2]Same amount of water applied as for A and B.

availability for seeds. Favorable rainfall and soil moisture after seeding lowers the osmotic concentration of the soil solution and causes soluble nutrients to move into the soil away from the seed so that good results may be expected from contact placement of seed and fertilizer. Fertilizers incorporated before seeding can and do seriously retard germination during periods of drought. During evaporation, soluble salts move to the soil surface in closer proximity to the seed thereby adding to the moisture stress. The placement of seed and fertilizer in contact on the soil surface will normally cause more injury to germination than incorporation of the fertilizer material. Seed and fertilizer are not necessarily placed in contact with the hydro-seeding method as fertilizer materials do penetrate into the soil surface when the seedbed is reasonably friable. Data reported here show excellent germination with high moisture where fertilizer and seeds were placed in contact on the surface.

TABLE 4

PERCENT GERMINATION OF KENTUCKY 31 FESCUE AS INFLUENCED BY SOIL MOISTURE WITH AND WITHOUT FERTILIZER

Fertilizer Treatment	Total Soil Moisture %			Average Germination for Fertilizer Treatments
	12	14	20	
	Available Soil Moisture %			
	1	3	9	
10-20-10 fertilizer on soil surface at 1,000 lb/A	12[1]	26[1]	50[1]	29[1]
No fertilizer	62	65	67	65
Average for 3 moisture levels[2]	36	46	59	

[1]Significantly lower than values for the no fertilizer treatment.
[2]Mean values differ significantly.

Turf stands during establishment are not as good on warm sunny slopes as on cool slopes, regardless of seeding method, because of more available moisture and more favorable temperatures on cool slopes. High temperatures on sunny slopes coupled with high water loss due to transpo-evaporation causes a moisture stress. Moisture stress is more serious in the presence of fertilizers high in soluble salts than in the absence of fertilizer or with fertilizers low in soluble salt concentration.

Laboratory and field results show that it is better to use high analysis fertilizers as compared with low analysis fertilizers. Salt concentration per unit available fertilizer applied is lower for high analysis than for low analysis fertilizers. Concentrated phosphates, such as triple superphosphate, do not seriously inhibit germination even though seeds are in contact with it. On the other hand, ordinary superphosphate which is high in gypsum causes serious retardation in germination under moisture stress. Concentrated forms of soluble nitrogen fertilizers cause less burning than the less concentrated soluble forms. Organic and urea-formaldehyde sources of nitrogen do not inhibit germination because of the low soluble salts.

The effect of soil moisture on germination of Kentucky 31 fescue was linear where fertilizer was applied with seed. These results suggest that the harmful effects of fertilizer contact with seed are overcome by favorable moisture. This conclusion is substantiated by the results in experiment I, which showed that fescue was not injured by soaking in a slurry.

SUMMARY

Experiments were conducted to study seed germination as influenced by soaking in fertilizer slurries and by moisture stress where seed and fertilizer are placed in contact on the soil surface. The results apply to hydro-seeding methods that are commonly used by highway departments and other agencies.

The soaking of seeds in fertilizer slurries for short periods of time that simulate hydro-seeding did not reduce germination of Kentucky 31 fescue, redtop, perennial ryegrass, red clover, white clover, oats, and millet. The germination of rye was reduced 21 to 43 percent by soaking in a slurry for 30 min.

The results with Kentucky 31 fescue show that fertilizer-seed contact (fertilizer not watered in) on the soil surface is injurious to germination under low available moisture. Fescue seed soaked in a slurry and placed in contact with the fertilizer increased in germination from 12 to 50 percent as available moisture was increased

from 1 to 9 percent, respectively. Fertilizer in contact with seed aggravated the stress for soil moisture.

The application of the results to hydro-seeding has been discussed.

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