Effects of Postemergence Herbicides on Seedling Development of Selected Legumes[1]

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ABSTRACT

Three herbicides were evaluated in a series of growth chamber experiments for possible phytotoxic or growth retarding effects on alfalfa (*Medicago sativa* L.), crimson clover (*Trifolium incarnatum* L.), and subterranean clover (*Trifolium subterraneum* L.) seedlings emerging through a straw mulch treated with the herbicides. After legumes were planted in a coarse, sterile sand and covered with a .25 in. layer of chopped bermudagrass, treatments of Fusilade (0, .125, .25, and .50 lb. a.i./acre), Roundup (0, .45, .90, and 1.8 lb. a.i./acre), and Paraquat (0, .25, .50, and 1.0 lb. a.i./acre) were applied. One-half of each herbicide treatment received a daily misting while the other received water only as needed to maintain plant health.

A daily misting apparently gave significantly higher emergence percentages compared to the 4-day interval when Paraquat was applied to either crimson or subterranean clover plantings. Herbicide treatment apparently had little or no effect on hypocotyl or radicle elongation of subterranean clover. However, a significant reduction in a radicle length was seen with the Roundup treatment on crimson clover while a similar trend was observed with subterranean clover.

INTRODUCTION

It is the objective of many forage growers to produce high quality vegetation throughout the year. This is often accomplished by overseeding perennial pastures with annual crops which grow most actively during periods in which the perennial crop is dormant. Previous studies have shown that certain postemergence herbicides provide effective seedbed preparation for establishment of grass and legume crops being interseeded into a perennial pasture (Appleby and Benchley, 1968; Lee, 1964; Salazar and Appleby, 1982). Two herbicides that are commonly used for chemical seedbed preparation are Paraquat (1, 1'dimethy 1-4, 4'bipyridinium ion) and Roundup [N-(phosphonomethyl)glycine]. Another chemical that may be of some value in this type of program is Fusilade (butyl 2[4'(6-trifluoromethyl-2pyridyloxy)phenoxy]-propionate).

Several researchers have indicated that a possible disadvantage of chemical desiccation might be that of damage caused to young seedlings emerging through plant residues that have been sprayed with herbicides (Hurto and Turgeon, 1979; Moshier et al., 1978; Moshier and Penner, 1978). The purpose of this study was to evaluate the effects of the previously mentioned herbicides on alfalfa (**Medicago sativa** L.), crimson clover (**Trifolium incarnatum** L.), and subterranean clover (**Trifolium subterraneum** L.) when emerging through residues treated with the herbicides.

MATERIALS AND METHODS

A bioassay study was conducted in three separate growth chamber experiments at Sam Houston State University Agronomy Lab. In each experiment, 72 aluminum loaf pans, approximately 4 in. × 8 in. × 3.5 in. deep were filled with washed, coarse sand. The 72 pans were divided into three groups of 24, each planted to either subterranean clover, crimson clover, or alfalfa. Twenty-five legume seeds were placed in each pan and covered with an additional 1/8 in. layer of sand. A layer of dried bermudagrass, chopped into 1½ in. lengths and approximately ¼ in. in depth was then placed in each pan. The 24 pans planted to each legume were further divided into four groups of six each. These four groups received the following rates of herbicide application:

Fusilade	Glyphosate	Paraquat
1. Control - no chemical	control	control
2. .125 lb. a.i./acre*	.45 lb. a.i./acre	.25 lb. a.i./acre
3. .25 lb. a.i./acre	.90 lb. a.i./acre	.50 lb. a.i./acre
4. .50 lb. a.i./acre	1.8 lb. a.i./acre	1.0 lb. a.i./acre

*a.i./acre - active ingredient per acre

Only one herbicide treatment was in the growth chamber at one time. Three replicates of each herbicide treatment on each legume were randomly arranged in the lower portion of the growth chamber and received a light daily misting with a hand sprayer upon emergence of the first seedlings. The purpose of the misting was to simulate the effect of morning dew each day during seedling emergence through the straw or grass covering under field conditions.

The other three pans of each group were randomly arranged in the upper portion of the growth chamber and the straw covering was misted only when providing necessary water to the seedlings at four day intervals.

The seedlings were allowed to grow for 21 days at temperatures of 60° F during the day and 54° F at night. Day length was set at 12 hours. After 21 days, 10 seedlings were randomly selected from each pan and carefully removed intact and measured for hypocotyl elongation, root length, and dry matter. Additionally, germination percentage was calculated for each pan. Data on subterranean clover and crimson clover were statistically analyzed by the analysis of variance (AOV) and Duncan's multiple range test. Data collected from alfalfa treatments could not be analyzed statistically due to numerous missing values caused by a low germination rate. The poor germination rate of the alfalfa was assumed to be due to poor seed quality based upon subsequent germination tests.

RESULTS AND DISCUSSION

The data presented in tables 1 and 2, comparing the two mist treatments, show insignificant effects of mist treatment on most parameters measured. Exceptions were noted in radicle length of crimson clover treated with paraquat in which daily misting produced a reduction, and percent emergence was improved by daily misting of both clovers treated with paraquat. A possible explanation for the reduced emergence with the 4-day misting treatment is that plants did not receive adequate moisture during this critical stage with the problem being corrected in the subsequent experiments with Roundup and Fusilade. These observations warrant further investigation using alternate means of supplying soil moisture and additional soil types, with and without the mulch covering.

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Table 1. The effect of daily misting vs. misting at 4-day intervals on crimson clover following herbicide application to a straw mulch covering, Huntsville, 1984.

Herbicide	Parameter	Mist Treatment	
		Daily	4-Day
Paraquat	Emergence (%)	70.7 a*	60.7 b
	Hypocotyl Length (in.)	.63a	.52a
	Radicle Length (in.)	.33a	.47a
	Dry Matter (mg/10 plants)	143a	136a
Roundup	Emergence (%)	55.0 a	57.7 a
	Hypocotyl Length (in.)	.32a	.45a
	Radicle Length (in.)	.25a	.28a
	Dry Matter (mg/10 plants)	108a	122a
Fusilade	Emergency (%)	90.3 a	90.0 a
	Hypocotyl Length (in.)	.58a	.47a
	Radicle Length (in.)	.33a	.29a
	Dry Matter (mg/10 plants)	105a	61a

* Mist treatment means followed by the same subscript within each row are not significantly different at the 5% level as determined by ANOVA and Duncan's multiple range test.

Table 2. The effect of daily misting vs. misting at 4-day intervals on subterranean clover following herbicide application to a straw mulch covering, Huntsville, 1984.

Herbicide	Parameter	Mist Treatment	
		Daily	4-Day
Paraquat	Emergence (%)	88.3 a*	68.0 b
	Hypocotyl Length (in.)	.52a	.48a
	Radicle Length (in.)	.34a	.38a
	Dry Matter (mg/10 plants)	111a	98a
Roundup	Emergence (%)	70.0 a	73.7 a
	Hypocotyl Length (in.)	.48a	.49a
	Radicle Length (in.)	.29a	.25a
	Dry Matter (mg/10 plants)	98a	111a
Fusilade	Emergence (%)	90.5 a	90.0 a
	Hypocotyl Length (in.)	.48a	.49a
	Radicle Length (in.)	.29a	.26a
	Dry Matter (mg/10 plants)	89a	89a

*Mist treatment means followed by the same subscript within each row are not significantly different at the 5% level as determined by ANOVA and Duncan's multiple range test.

As a consequence of the inconclusive or insignificant effects observed due to mist treatment, tables 3 and 4 display means averaged across the mist treatments. For the most part, herbicide treatment had little or no significant effect on seedling development of either clover. However, radicle length in crimson clover was significantly reduced with the Roundup treatment. The same general trend was observed with subterranean clover, but the differences were not statistically significant. No other definite trends were noticed with either clover regardless of treatment. Glyphosate (active ingredient in Roundup) treatment with a high concentration solution (10^{-4} M) was reported to reduce shoot growth but not root growth on red fescue (**Festuca rubra** L.) and Kentucky bluegrass (**Poa pratensis** L.) (Moshier et al., 1976). Moshier and Penner (1978) also found that glyphosate applied at higher rates (10^{-6} M solution) could cause a reduction in the shoot length of vernal alfalfa. It is interesting to note that we did not observe a significant reduction in shoot length with either clover. It is unlikely that Roundup rates any higher than those used in this study could be used in a sod desiccation program without causing significant damage or death of the sod crop.

Table 3. The effect of various herbicide treatments on crimson clover, averaged across mist treatments, Huntsville, 1984.

Herbicide Treatment (lb.a.i./acre)	Emergence (%)	Hypocotyl Length (in.)	Radicle Length (in.)	Dry Matter (mg/10 plants)
Fusilade				
Control	85.3a*	.54a	.30a	109a
.125	76.0a	.56a	.28a	89a
.25	79.3a	.52a	.35a	69a
.50	71.3a	.50a	.32a	97a
Roundup				
Control	59.3a	.50a	.46a	146a
.45	54.0a	.45a	.24b	123a
.90	58.0a	.35a	.17b	88a
1.80	54.0a	.42a	.18b	132a
Paraquat				
Control	55.3b	.57a	.44a	159a
.25	65.3a	.60a	.38a	124a
.50	68.7a	.56a	.38a	132a
1.0	73.3a	.58a	.40a	144a

*Means with the same subscript within a column and within a herbicide are not significantly different at the 5% level according to ANOVA and Duncan's multiple range test.

Table 4. The effect of various herbicide treatment on subterranean clover, averaged over mist treatments, Huntsville, 1984.

Herbicide Treatment (lb.a.i./acre)	Emergence (%)	Hypocotyl Length (in.)	Radicle Length (in.)	Dry Matter (mg/10 plants)
Fusilade				
Control	85.3a*	.43a	.30a	87a
.125	90.0a	.46a	.28a	72a
.25	90.7a	.40a	.29a	97a
.50	94.7a	.44a	.30a	67a
Roundup				
Control	76.0a	.51a	.32a	120a
.45	67.3a	.53a	.31a	105a
.90	77.3a	.44a	.25a	100a
1.8	66.7a	.46a	.21a	93a
Paraquat				
Control	74.0a	.49a	.35a	112a
.25	80.0a	.51a	.33a	108a
.50	83.3a	.49a	.36a	80a
1.0	75.3a	.51a	.39a	118a

*Means with the same subscript within a column and within a herbicide are not significantly different at the 5% level according to ANOVA and Duncan's multiple range test.

SUMMARY AND CONCLUSIONS

The data from this study indicate that fusilade and paraquat could be used in a sod desiccation program for the establishment of crimson or subterranean clover without any danger of reducing germination or seedling development. A field study is currently being conducted to evaluate the effects of these compounds on a bermudagrass sod when Fall applied. Although glyphyosate had no apparent effect on subterranean clover in regards to seedling development, the trend noted on seedling emergence and its significant effect on crimson clover warrant further investigation.

From these data, it appears that dew formation following herbicidal application (simulated by mist treatments) would have little or no effect on legume seedlings emerging through plant residues that had been treated with the herbicides. Evidently, the activity of the herbicides is much reduced by the time actual seedling emergence takes place. This is possibly due to inactivation by environmental elements. Possibly, the misting treatment was sufficiently heavy to wash herbicides from the straw mulch into the soil, thereby causing reduced radicle elongation due to herbicide activity in the soil solution with Roundup. This is assumed to be possible only because the sand used in this study was sterile and possessed no chemical activity that might have otherwise rendered the Roundup inactive.

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Earth Sheltered Structures: Soil Temperature Variation and Site Aesthetics[1]

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ABSTRACT

Soil temperature variations were evaluated at an earth-sheltered church and several ancillary sites in Lubbock, Texas. The objectives were to compare the fluctuations in soil temperature over an existing earth sheltered structure versus those in a native soil, and to evaluate the influence of vegetation and water management on soil temperature fluctuations. In experiment I, thermocouples were installed at various depths under a bermudagrass (Cynodon dactylon) turf above the roof of an earth sheltered church and in a similarly vegetated area adjacent to the church. Temperatures were measured daily in both sites at four depths from July, 1983 through March, 1986. Mean soil temperatures above the roof were approximately 5° F warmer from March to September and 5° F cooler from October to February than the adjoining soil area. In a second experiment, the vegetative cover was evaluated using (1) bermudagrass, (2) buffalograss (Buchloe dactyloides), (3) and bare soil. Results indicated grass covers did not significantly (<2° F) influence temperatures below 18 in. Separate water management studies indicated less temperature fluctuation in moist soils than in dry soils (11 vs. 14° F) and temperature fluctuation was greater (14 vs. 9° F) in summer than winter. Soil cover no deeper than 18 in. and plants able to thrive without irrigation should be advocated for this area's earth sheltered structures.

INTRODUCTION

Earth-sheltered structures are as old as humankind and as new as tomorrow. Golanz (1986) reported on below-ground dwellings in use for 4000 years in Turkey and on those currently inhabited by 40,000,000 Chinese in the loessial soils the controlling factor in the determination of architectural design. Today, earth-sheltered architecture has grown in popularity faster than technology can define its optimal design. In the interim, architects, builders, and engineers have progressed in the construction of earth-sheltered buildings guided by a blend of climatic knowledge and "conventional wisdom" (Geiger, 1965; Underground Space Center, 1982).

Supplementing the insulative quality of soil with plant materials in earth-sheltered structures is one example of conventional wisdom used to respond to contemporary situations. Depending on characteristics such as those of the site, (Robinette, 1976a), soil (Wright, 1986), plant materials (Taylor and Terrell, 1982; Robinette, 1972), and geography (Labs, 1982) designers modify the basic earth-sheltered shell to attempt to provide superior energy efficiency and aesthetics. Experience indicates that though deciduous woody ornamentals provide shade during the summer and light transmission in the winter, they are too deep rooted to be used above earth sheltered structures (Robinette, 1976b). However, deciduous woody ornamentals may be planted outside the soil envelope surrounding the earth sheltered structure to provide shading for entrances and wells. Herbaceous plant materials are more suited for "above structure" planting due to shallower rooting depths (Taylor and Terrell, 1982). Plant materials also have an important aesthetic role in the development and acceptance of earth-sheltered housing. The need exists to document vegetation and water management influences on temperature variation over earth-sheltered structures. Our objectives were to evaluate the fluctuation in soil temperature over an existing earth-sheltered structure and to investigate the influence of several vegetation and water management schemes on soil temperature variation.

MATERIALS AND METHODS

This study consisted of three independent experiments conducted in Lubbock, Texas. Data were analyzed using a completely randomized design with split plots (locations).

Experiment I: The primary site for this experiment was St. John Neumann Catholic Church, which is virtually earth

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