Emergence and Survival Response of Seven Grasses for Six Wet-Dry Sequences

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Abstract

A greenhouse study was conducted to determine seedling emergence and survival responses of 7 warm-season grasses to 6 combinations of initial wet-day and dry-day water sequences. Two factors which affected the number of seedlings that survived the first wet-dry watering sequence following planting were: (1) the number of seedlings produced in the first wet period which developed sufficient vigor to survive the subsequent drought or dry period, and (2) the number of ungerminated but viable seeds which remain after the first wet-dry watering sequence. Sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.) seedlings emerged within 18 h of the initial wetting, with maximum numbers occurring on days 2 and 3. There was a high seedling mortality during the dry periods. 'Cochise' lovegrass (*Eragrostis lehmanniana* Nees × *E. trichophora* Coss and Dur.), 'Catalina' Boer lovegrass (*E. curvula* var. *conferta* (Schrad.) Nees), and 'A-130' and 'SDT' blue panicgrass (*Panicum antidotale* Retz) emerged on day 2 or later, and maximum seedling counts occurred on days 4 to 6. 'A-68' Lehmann lovegrass (*E. lehmanniana* Nees) and 'A-84' Boer lovegrass did not have significant emergence until there were 3 or more consecutive wet days. Seedling mortality, during dry periods of 2 to 7 days following initial wetting, ranged from 0 to 70% of the viable seeds. Survival characteristics of the grasses were not directly affected by total water loss. There were differences within varieties of the same species, and some grasses were better suited for surviving short term droughts during early seedling stages. These studies provided information showing how the survival characteristics of plants to the first wet-dry watering sequence can be used to assist in selecting species for range revegetation.

The timing and quantity of precipitation immediately following seeding are 2 factors which significantly affect the success of rangeland revegetation efforts. Cox and Jordan (1983) found that the quantity and frequency of first-year growing-season precipitation was a major factor in explaining plant densities and forage production measured 11 years after planting in southeastern Arizona. McLean and Wikeem (1983), in British Columbia, found that the persistence of available soil moisture at the time of seeding was the most important single factor in seedling establishment. Frasier et al. (1984) showed that the initial germination and seedling survival of sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.) and 'Cochise' lovegrass (*Eragrostis lehmanniana* Nees × *E. trichophora* Coss and Dur.) was directly affected by the relative lengths of the first wet and dry periods following seeding. They demonstrated how a basic understanding of plant-water relations and plant responses could be combined with probability models of the occurrences of natural precipitation-drought combinations to develop a description of the seedling environment to guide in selecting the optimum time for seeding.

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Research Hypothesis:

To use the concept of combining rainfall occurrence probabilities and seedling survival characteristics, it is first necessary to develop an understanding of the seedling response characteristics of various plant species to the initial wet and dry periods following seeding. This study was to determine if there are differences in the means of live seedlings between species or accessions and watering sequences. There are several possible response alternatives for seed germination, seedling emergence following the initial wet period. If the first wet period is short, the seeds may not germinate and will survive the wet-dry watering sequence as viable seeds. If the wet period is long enough to germinate most seeds, and is followed by a long dry period, many, if not all, of the plants will die. If the first wet period is long enough for the seedlings to develop a root system and plant vigor sufficient to survive a drought-induced quiescence, a high percentage of the plants might survive a long drought period. For a wet period of length L_1, followed by a dry period of length L_0, there will be a particular response in the number of viable seeds, viable seedlings, and dead seeds or seedlings at the end of the drought period.

If $N(t)$, $t = 0, 1, 2, \cdots, 14$ signifies the number of live seedlings observed on an area on day t, the outcome of an experiment of length $t = 14$ can be described by the random vector $(n_1, n_2, \cdots, n_{14})$, $N(0) = n_0 = 0$; $N(t) \leq m$ where m = number of pure live seeds planted. A completed description of the process $N(t)$ requires that the multivariate distribution function

$$F(n_1, n_2, \cdots, n_{14}) = P\{N(1) \leq n_1, N(2) \leq n_2, \cdots, N(14) \leq n_{14}\} \quad (1)$$

be specified. With 7 grasses and 6 water treatments, samples are taken from 42 different 14-variate populations. The hypothesis to be examined is that the parent populations are identical.

Hypothesis testing in multivariate analysis is confined to the multivariate normal case (Kendall et al. 1983). Distributions within this study are discrete, not multivariate normal, which makes it necessary to modify the approach. The usual procedure is to consider a single random variable and to test hypotheses regarding one particular parameter, such as the mean. This simplification is justified, since the study is primarily exploratory, rather than confirmatory (Tukey 1977).

A typical sample function of the process $N(t)$ is shown (Figure 1) for a specified wet-dry sequence of t_w wet days followed by a dry period of $t_d - t_w$ days. For each experiment, the following discrete random variables can be identified: (1) N_{max}, the maximum number of emerged seedlings during, or following, the first wet period, (2) t_{max}, the number of days from planting till N_{max} was observed, (3) N_{min}, the minimum number of live seedlings observed after t_{max}, and (4) $N(14)$, the number of live seedlings on day 14, the end of the experiment. By inference, $L = N_{max} - N_{min}$, which is the minimum number of seedlings that died during the study, while

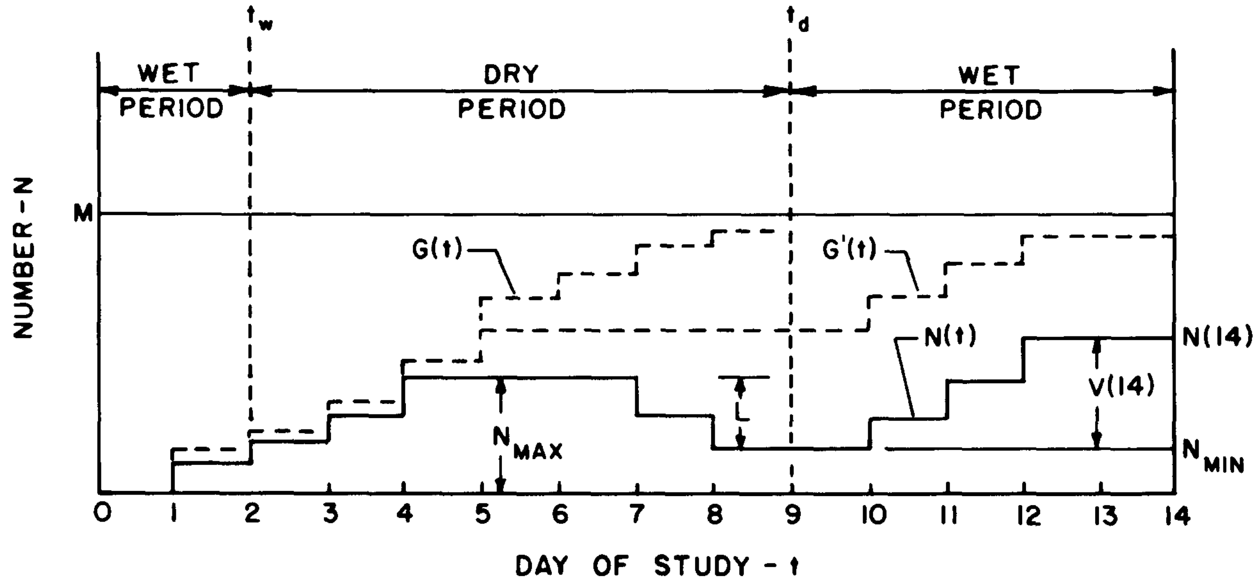

Fig. 1. *Definition sketch of seedling emergence response to the first wet-dry water sequence.*

$V(14) = N(14) - N_{min}$ which is the minimum number of viable seeds at day t_d. The process G(t), the number of germinated seeds at time t with no dry period, G'(t), the number of germinated seeds with a dry period, is also illustrated (Fig. 1).

Materials and Methods

The grasses used in the study were 'Premier' sideoats grama, 'Cochise' lovegrass, 'A-68' Lehmann lovegrass (*Eragrostis lehmanniana* Nees), 'Catalina' and 'A-84' Boer lovegrass (*E. curvula* var. *conferta* (Schrad.) Nees), and 'A-130' and 'SDT' blue panicgrass (*Panicum antidotale* Retz). The A-68 and Cochise lovegrass are from similar genetic lines (Holzworth 1980). Catalina lovegrass is a selection from A-84 lovegrass (Wright and Jordan 1970, Wright 1971), and the SDT blue panicgrass is a selection from A-130 panicgrass (Wright and Dobrenz 1970). The Premier sideoats grama seeds were provided by Rancho Experimental La Campana, SARH, INIP, Chihuahua, Chihuahua, Mexico. Other grass seeds were provided by the Tucson Plant Materials Center, USDA-SCS, Tucson, Ariz. Seed lot germination percentages (pure live seed, PLS) were: Premier sideoats-97%, Cochise lovegrass-80%, A-68 lovegrass-68%, Catalina lovegrass-52%, A-84 lovegrass-82%, A-130 panicgrass-76%, and SDT panicgrass-42%.

The studies were conducted in an evaporative cooled greenhouse using the procedure reported by Frasier et al. (1984). Tapered plastic cones, 3.8-cm in diameter by 20 cm long, with 2 cotton balls placed in the bottom, were filled with 210 g of dry 60-mesh silica sand. Sand was used to provide a reproducible, uniform growth media, and to reduce problems of undesirable seed contamination. Thirty cones were prepared for each grass species or accession per watering sequence. Ten seeds were placed on the dry surface of each cone and covered with a 2- to 3-mm layer of dry sand.

Watering sequences used in the studies were: (1) 2 days wet, 5 days dry; (2) 1 day wet, 7 days dry; (3) 2 days wet, 7 days dry; (4) 3 days wet, 7 days dry; (5) 2 days wet, 2 days dry; and (6) 3 days wet, 3 days dry. The watering sequences represented possible precipitation patterns which may occur during the early summer growing season in southern Arizona. The number of cones required per watering sequence precluded a simultaneous comparison of all watering sequences and all grass species. Two watering sequence experiments were conducted at a time (Table 1).

Water was sprinkled onto the cones, in the predetermined wet-dry-wet days watering sequence, with an overhead reciprocating spray system. Ten percent of the total number of cones in an experiment were randomly selected and marked for daily weighing, to determine evapotranspiration losses and the quantity of applied water.

Table 1. Wet-dry-wet watering sequences used in the experiments.

Experiment no.	Water sequence	Period wet	Period dry	Period wet
		(days)	(days)	(days)
1	2-2	2	2	10
	2-5	2	5	7
2	3-3	3	3	8
	3-7	3	7	4
3	1-7	1	7	6
	2-7	2	7	5

All cones were initially wetted to approximate field capacity with 20 g of water (≃10% moisture by weight). In the wet periods, cones were sprinkled daily with sufficient water to bring the average moisture content of the cones to the original field capacity weight. Cones in a dry-day period were covered during sprinkling with an 18-gauge galvanized sheetmetal roof. A 5-ml application of one-quarter strength Hoagland solution was given to each cone on day 10.

The 210 cones per watering sequence were randomly divided into three 70-cone replications, 10 cones of each grass per replication. The number of live plants in each cone was counted and recorded daily. For each species, the mean plant count of the 10 cones per replication was determined for each day.

There are 3 specific periods, during the 14-day experiments, when the number of seedlings are of significant interest. It is important to determine: (1) the maximum number of seedlings (N_{max}) resulting from the initial wet period; (2) the minimum number of seedlings (N_{min}) surviving the dry period; and (3) the number of seedlings at the end of the second wet period (N(14)) when all surviving seeds have germinated. Because the mean daily plant counts can be considered as random variables, dependent only upon the watering sequence, values of N_{max}, N_{min}, and N(14) between species, even though N_{max} and N_{min} may occur on different days, can be compared. For the purpose of analysis, N_{max} is the maximum number of seedlings prior to the start of the second wet period (t_d), N_{min} is the minimum plant count between the day on which (N_{max}) occurs and day (t_d + 1).

As previously noted, all water treatments were not conducted simultaneously. This limited the statistical testing of the hypothesis to the paired water treatments. Replication means of N_{max}, N_{min}, and N(14) were subjected to analysis of variance to determine differences between species and watering sequences. When "F" values were significant ($P \leq 0.05$), Duncan's new multiple range test was used to separate means (Steel and Torrie 1960).

Results and Discussion

Initial Seedling Emergence

Premier sideoats grama seedlings were observed within 18 h of the initial wetting, with maximum initial seedling counts (N_{max}) occurring at days 2 to 3 (Table 2). Seedling emergence of the other grasses was not observed until day 2 or later, with N_{max} occurring on days 3 to 6.

With all 3 experiments, there were significant differences in N_{max} between species or accession ($P \leq 0.05$). Only in Experiment No. 3 (1–7, 2–7 watering sequences) were there significant interactions on N_{max} between watering sequences and species. With the Cochise and Catalina lovegrass and the two blue panicgrasses, N_{max} was significantly higher with 2 days wet than with 1 day wet (Table 2).

With the 1-day initial wet period (Experiment No. 3), Premier sideoats grama has the highest N_{max}, based on PLS planted, followed by A-130 panicgrass and the Catalina and Cochise lovegrasses (Table 2). With 2 or more wet days (Experiments No. 1 and No. 3), the Catalina lovegrass had the highest percentage of initial seedling emergence, followed by Premier sideoats or A-130 panicgrass, with Cochise lovegrass ranked fourth. Differences in the mean N_{max} seedling emergence of the grasses were not always significant ($P \leq 0.05$).

Ranking the initial seedling emergence response places Premier sideoats grama, A-130 panicgrass, and the Cochise and Catalina lovegrasses at the top, depending upon the watering sequence, followed by the SDT panicgrass. Even with 3 wet days, initial seedling emergence of the A-68 and A-84 lovegrasses was very low. However, Cox and Jordan (1983) reported them to be relatively persistent range grasses in southern Arizona. It might be expected that the higher the ranking, the easier it would be to produce a seedling.

Seedling Mortality

In all 3 experiments, there were some differences ($P \leq 0.05$) among grasses in the minimum number of seedlings surviving the dry period (N_{min}). Ranking the grasses showed Catalina lovegrass with the largest N_{min}, followed by the Cochise lovegrass, A-130 panicgrass, and Premier sideoats grama. The A-84 and A-68 lovegrasses had the lowest numbers of seedling survival (Table 2). Only in Experiment No. 3 was there a significant interaction between the watering sequences and species ($P \leq 0.05$). With the exception of the A-84 and A-68 lovegrasses, there were more surviving seedlings with 2 wet days than with 1 day wet (Table 2). This indicated that with the extra day of water, a more durable seedling is produced.

Some of the differences in N_{min} can be attributed to a carryover

Table 2. Mean plant count, based on pure live seed, of the initial maximum seedling emergence, N_{max}, seedlings surviving dry period, N_{min}, and the number of seed and seedlings surviving the wet-dry watering sequence, N(14), of seven grass species or accessions with six wet-dry watering sequences.

Period	Water sequence (wet-dry) days	Species: 'Premier' sideoats grama	'A-68' Lehmann lovegrass	'Cochise' Atherstone lovegrass	'A-84' Boer lovegrass	'Catalina' Boer lovegrass	'A-130' blue panicgrass	'SDT' blue panicgrass
				Experiment No. 1				
Initial -N_{max}	2-2	(2)[1]69.7	(2) 0.5	(3)52.9	(3) 1.6	(3) 80.0	(3)59.8	(3)17.4
	2-5	(3) 69.4	(3) 0.0	(4)52.9	(4) 1.2	(3) 76.8	(3)63.4	(3)23.0
	$\bar{X}$	69.5ab[2]	0.2d	52.9b	1.4d	78.4a	61.6b	20.2c
Dry -N_{min}	2-2	(5) 35.7	(4) 0.0	(4)58.3	(4) 3.7	(4) 85.1	(4)40.9	(4)19.8
	2-5	(7) 20.6	(7) 0.0	(7)47.1	(7) 0.8	(7) 57.0	(7)34.3	(8)13.5
	$\bar{X}$	28.2c	0.0d	52.7b	2.2d	71.0a	37.6bc	16.7d
Final -N(14)	2-2	(14) 36.1	(14)22.1	(14)75.8	(14)24.4	(14)100.0	(14)56.3	(14)53.2
	2-5	(14) 25.4	(14)19.6	(14)64.2	(14)26.4	(14) 89.6	(14)46.2	(14)41.3
	$\bar{X}$	30.7d	20.8d	70.0b	25.4d	94.8a	51.2bc	47.2cd
				Experiment No. 2				
Initial -N_{max}	3-3	(2) 65.2	(5) 3.4	(4)64.6	(5)12.6	(5)100.0	(4)71.3	(4)31.7
	3-7	(2) 70.4	(5) 6.9	(5)65.8	(5)10.6	(5)100.0	(4)81.8	(5)41.3
	$\bar{X}$	67.8b[2]	5.1d	65.2b	11.6cd	100.0a	76.6b	36.5c
Dry -N_{min}	3-3	(6) 52.2	(7) 1.0	(5)65.4	(7) 3.7	(7)100.0	(6)56.8	(6)16.7
	3-7	(10) 37.1	(10) 0.0	(10)60.0	(9) 2.0	(10) 96.0	(10)65.1	(10)30.9
	$\bar{X}$	44.6c	0.5d	62.7b	2.8d	98.0a	60.9b	23.8c
Final -N(14)	3-3	(14) 54.6	(14)11.8	(14)69.2	(14)16.7	(14)100.0	(14)64.2	(14)38.1
	3-7	(14) 39.8	(14)15.2	(14)69.2	(14)25.2	(14) 96.0	(14)67.8	(14)36.5
	$\bar{X}$	47.2c	13.5d	69.2b	20.9d	98.0a	66.0b	37.3cd
				Experiment No. 3				
Initial -N_{max}	1-7	(2) 65.9b[3]	(4) 0.0d	(4)31.7c	(4) 0.0d	(4) 39.7c	(3)34.8c	(3)15.9d
	2-7	(2) 65.9b	(4) 0.5d	(6)65.8b	(5) 2.0d	(6)100.0a	(3)69.1b	(5)42.8c
Dry -N_{min}	1-7	(8) 24.6c	(8) 0.0d	(8)27.1c	(8) 0.0d	(7) 33.9c	(9)20.2c	(8)11.1c
	2-7	(9) 51.8b	(9) 0.0d	(10)57.9b	(9) 0.4d	(8) 96.6a	(9)60.7b	(9)34.1c
Final -N(14)	1-7	(14) 44.6cd	(14)19.1e	(14)55.0bc	(14)26.8d	(14) 94.7a	(14)47.1cd	(14)34.9d
	2-7	(14) 54.9bc	(14)15.2e	(14)62.9bc	(14)36.6d	(14) 96.6a	(14)70.8b	(14)63.4bc

[1]Numbers in parenthesis are the day of the experiment.
[2]No significant water treatment vs. species interaction or significant differences between water treatments in experiments No. 1 and No. 2. Numbers in a row of means ($\bar{X}$) for a given period within an experiment, followed by the same letter, are not significantly different ($P \leq 0.05$).
[3]Numbers in columns and rows for a given period, followed by the same letter, are not significantly different ($P \leq 0.05$).

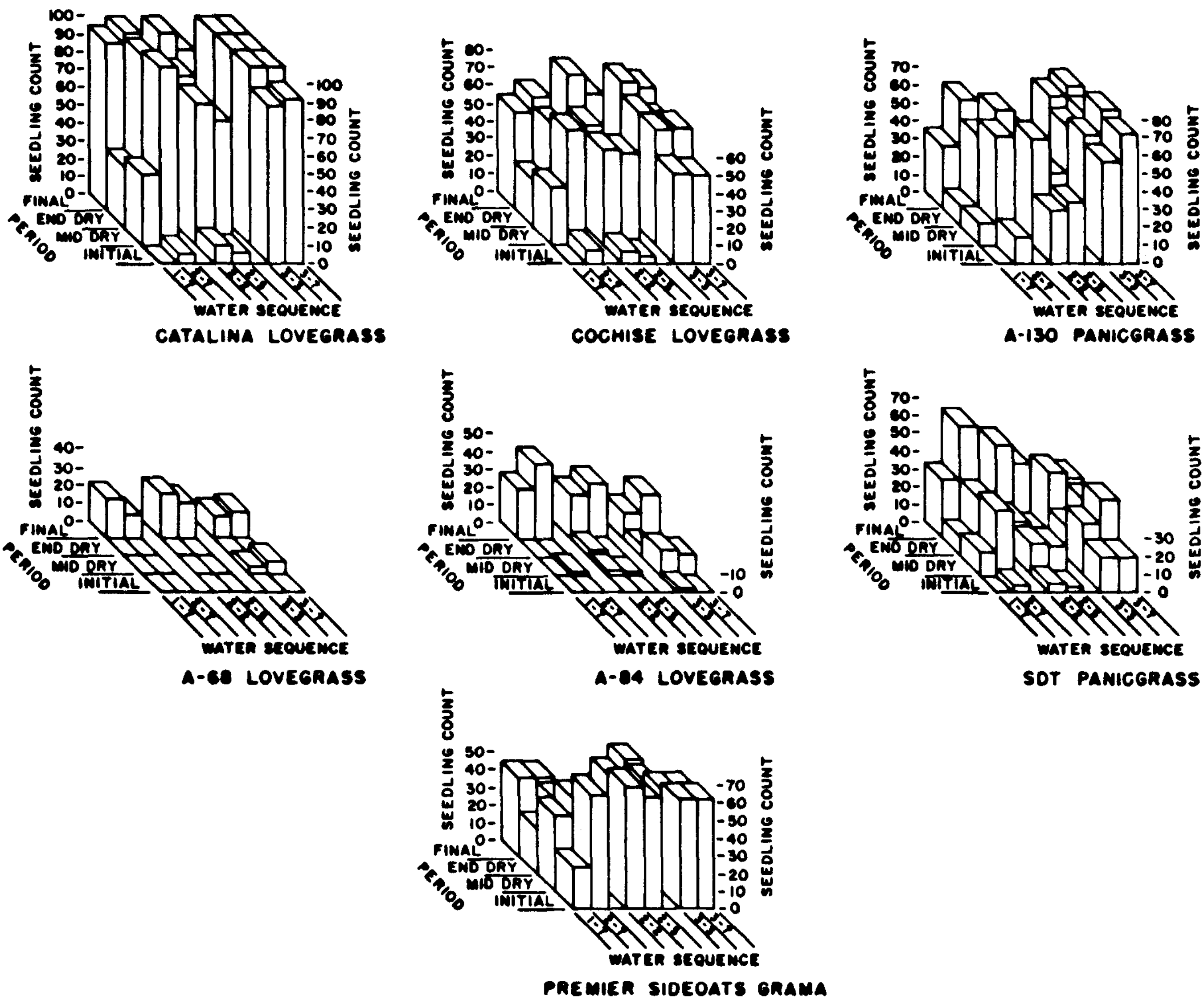

Fig. 2. *Percentage of viable seeds planted which emerged as seedlings for 7 warm-season grasses with 6 wet-dry water sequences at 4 periods during 14-day experiments.*

of the differences in the number of initial seedling emergence, N_{max}. The differences between N_{max} and N_{min} for various lengths of dry periods are a potential measure of a plant drought tolerance. The relative seedling mortality of the grasses which died during the dry period is presented as a percentage of the initial number (N_{max}) of seedlings (Table 3). Quantifying the seedling mortality characteristics of A-68 and A-84 lovegrasses was not possible because of the limited number of seedlings which emerged during the initial wet period. The Premier sideoats grama grass had the highest seedling mortality, and the Cochise and Catalina lovegrasses had the lowest seedling mortality rates within each watering sequence. This indicates that the Premier sideoats grama may have the lowest drought tolerance, and the Cochise and Catalina lovegrasses the highest drought tolerance.

Seed and Seedling Survival

There are 2 conditions that favor the survival of a viable seed or seedling during a dry period. These are: (1) a wet period that is short, with respect to the time for seed germination such that the seed remains viable, but does not germinate during the wet-dry period, and (2) a wet period of sufficient length plus plant growth characteristics that produces a seedling with sufficient vigor and root development to survive the following dry period. It might be expected that the longer the wet period, the greater the chance for a seedling to survive a short-term drought. With some species, there is the possibility that, with moderate length wet periods, more seedlings may initially emerge, but be in a growth stage that is susceptible to a drought.

In all water sequences, the Catalina lovegrass had the highest percentage (89.6–100% PLS) of seeds and seedlings surviving the initial wet-dry period (N(14)), with the A-84 and A-68 lovegrasses having the lowest numbers of surviving seedlings (Table 2). There were again some significant differences in N(14) between species or accessions, but only in Experiment No. 3 was there a significant interaction between the watering sequence and the grass species ($P \leq 0.05$). Across all grass species, there were more surviving seedlings with the 2–7 watering sequence than with the 1–7 watering sequence. The extra day of water produced more initial seedlings (N_{max}), and there was a lower seedling mortality with 2 wet days than with only 1 wet day. Evidently, the seedlings were better able to survive the dry period.

Table 3. Percent of initial seedlings (N_{max}) which died during the dry period of 7 grass species or accessions with 6 wet-dry watering sequences.

Experiment No.	Water sequence (wet-dry) days	Species: 'Premier' sideoats grama	'A-68' Lehmann lovegrass	'Cochise' Atherstone lovegrass	'A-84' Boer lovegrass	'Catalina' Boer lovegrass	'A-130' blue panicgrass	'SDT' blue panicgrass
1	2-2	48.8	—[1]	0.0	—	0.0	31.6	0.0
	2-5	70.3	—	11.0	—	25.8	45.9	41.3
		$\bar{X}$ 59.6a[2]		5.5c		12.9c	38.8b	20.7c
2	3-3	19.9	—	0.0	—	0.0	20.3	47.3
	3-7	47.3	—	8.8	—	4.0	20.4	25.2
		$\bar{X}$ 33.6a		4.4c		2.0c	20.3b	36.3a
3	1-7	62.7	—	14.5	—	14.6	42.0	30.2
	2-7	21.4	—	12.0	—	3.4	12.2	20.3
		$\bar{X}$ 42.1a		13.2c		9.0c	27.1ab	25.2bc

[1]Insufficient numbers of initial seedlings to make evaluation.
[2]No significant water treatment vs. species interaction or significant differences between water treatments. Numbers in a row of means ($\bar{X}$) for a given period within an experiment, followed by the same letter, are not significantly different ($P<0.05$).

Some of the differences in the final seedling count were a direct result of the relative numbers of initial seedling emergence N_{max}, and the percentage seedling mortality during the dry period. An additional factor is the number of viable seeds which survived the dry period V(14) (Fig. 1). A plant species may be better adapted to surviving long drought periods if there is a relatively high number of seeds surviving the first wet-dry watering sequence. The percent of the final seedling counts which are a result of seeds surviving the wet-dry periods is presented in Table 4. Over 84% of the final number of A-84 and A-68 lovegrass seedlings were from seeds surviving the wet-dry watering sequence and germinated during the second wet period. Conversely, less than 20% of the final Premier sideoats grama seedlings were from surviving seeds, except with the 1-7 watering sequence. The percentage of Cochise and Catalina lovegrasses and the 2 panicgrasses' seeds surviving the initial wet-dry water sequence was influenced by the relative length of the wet-dry periods. The A-130 panicgrass had a lower percentage of final seedlings resulting from ungerminated seeds than did the SDT.

A common way of rating the potential suitability of a species to an area is with respect to the total annual or growing season precipitation. In these studies, the average daily water loss during the wet periods was relatively uniform at 3 to 5 mm per day. Average daily water loss decreased during the dry periods to less than 1 mm per day by the end of the 7-day dry period. Total water use in the studies varied from 32 mm in the 1 day wet, 7 day dry to 54 mm in the 2 day wet, 2 day dry study. There was no correlation of seedling survival to total water availability or loss.

Seedling Emergence Characteristics

Seedling emergence characteristics of the 7 grasses at 4 periods during the three 14-day experiments are shown in Fig. 2. The initial period ends at the end of the wet sequence , (t_w) (Fig. 1). The mid-dry period is approximately the middle of the dry period. The end-dry period is the end of the dry period, t_d (Fig. 1), when the average water content in the cones is at a minimum and plant die off is at maximum. The final period is the termination of the experiment, with the plant count representing the total of seeds and seedlings (N(14) which survived the wet-dry watering sequence.

The A-68 and A-84 lovegrasses and the SDT panicgrass had one type of seedling response characterized by low initial seedling emergence, even with 3 wet days. This was combined with a low final seedling count (N(14) < 40% of viable seeds for the lovegrasses), which indicated that many seeds may have germinated but did not emerge as seedlings.

The Catalina and Cochise lovegrasses and A-130 panicgrass exhibited a second (N(t)) seedling emergence response. This type is characterized by good initial seedling emergence, with minor seedling mortality during the dry period. The Catalina lovegrass had the most final seedling counts, with a (N(14)) count of 95–100% of viable seeds. The A-130 panicgrass and the Cochise lovegrass required 2 or more wet days for good seedling emergence with N_{max} reaching 50–70% of viable seeds by the mid-dry period.

The sideoats grama had a third type of seedling emergence pattern. There was good initial seedling emergence and high seed-

Table 4. Percent of final seedling counts which survived the wet-dry period as seeds for 7 grass species or accessions with 6 wet-dry watering sequences.

Period	Water sequence (wet-dry) days	Species: 'Premier' sideoats grama	'A-68' Lehmann lovegrass	'Cochise' Atherstone lovegrass	'A-84' Boer lovegrass	'Catalina' Boer lovegrass	'A-130' blue panicgrass	'SDT' blue panicgrass
1	2-2	1.1	100.0	23.1	84.8	14.9	27.4	62.8
	2-5	18.9	100.0	26.6	97.0	36.4	25.8	67.3
		$\bar{X}$ 10.0d[1]	100.0a	24.9c	90.9a	25.7c	27.4c	65.1b
2	3-3	4.4	91.5	5.5	77.8	0.0	11.5	56.2
	3-7	6.7	100.0	13.3	96.0	0.0	4.0	15.3
		$\bar{X}$ 5.6d	95.8a	9.4d	86.9b	0.0d	7.8d	35.8c
3	1-7	44.8b[2]	100.0a	50.7b	100.0a	64.2b	57.1b	68.2b
	2-7	5.6c	100.0a	7.9c	98.9a	0.0c	14.3c	46.2b

[1]No significant water treatment vs. species interaction or significant differences between water treatments in experiments No. 1 and No. 2. Numbers in a row of means ($\bar{X}$) for a given period within an experiment, followed by the same letter, are not significantly different ($P<0.05$).
[2]Numbers in columns and rows for a given period, followed by the same letter, are not significantly different ($P\leq0.05$).

ling mortality during the dry period. Less than 60% of the viable seeds survived the wet-dry water sequence.

Summary and Conclusions

Two factors were found which affected the number of seedlings of selected warm-season grasses which survived the first wet-dry watering sequence following planting. These were: (1) the number of seedlings produced in the first wet period which developed sufficient vigor to survive the subsequent drought or dry period, and (2) the number of seeds which remained viable but ungerminated during the first wet-dry watering sequence.

These studies showed that A-68 and A-84 lovegrasses have slow seedling emergence characteristics, requiring at least 3 wet days. Most of the plants resulted from seeds which survived short wet periods. The SDT blue panicgrass had similar characteristics. With a slightly higher initial seedling establishment, SDT panicgrass seedlings may be more susceptible to a dry period than the A-68 and A-84 lovegrasses. If the longevity of established SDT plants is comparable to the A-68 and A-84 lovegrasses, it would be expected that the SDT panicgrass would be a persistent range plant. The slow seedling emergence characteristics of these 3 grasses may cause problems in achieving successful field planting, unless it is a wet year with frequent precipitation events.

The Catalina lovegrass and Premier sideoats grama were good in initial seedling establishment; but sideoats seedlings were susceptible to short dry periods (2 to 7 days), whereas the Catalina lovegrass seedlings were able to survive. The A-130 panicgrass and the Cochise lovegrass had desirable characteristics of both good seeding establishment, like sideoats grama, and seed survival like A-68 lovegrass.

For long-term persistence and natural reseeding of range grasses, it may be desirable to have plants which produce a seed which will not germinate fast, but will remain viable in the soil for long periods, such as the A-68 and A-84 lovegrasses. For reseeding projects, plants with early seedling establishment characteristics, like the Premier sideoats grama and the Catalina lovegrass, may be desirable, providing that the time of seeding can be selected to minimize the potential seedling loss during the first dry period.

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Greenhouse studies cannot duplicate field conditions, but they do demonstrate the wide range in response of grass species to the characteristics of the first wet-dry sequence after planting. There is the possibility that the seeds will germinate in the wet period and survive the dry period as germinated. The possibility of seeds surviving a dry period in a germinated state cannot be observed directly in studies with a soil growth media. The study was not able to determine if this is a common or important feature. Results suggested that the response of these same species to the first wet-dry sequence, in combination with a probabilistic description of the wet-dry sequences, may provide an objective method for selecting plant species and planting times for optimum survival at a given location. Further studies are needed to determine the sensitivity of the decisions that might be made (i.e., optimum planting date or best grass species) to alternative models of rainfall sequences,and to field or greenhouse evaluation of the seedling response function.

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