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THE EFFECT OF SEED SIZE ON RESEEDING IN THE PRESENCE OF HETEROMYIDS

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THE EFFECT OF SEED SIZE ON RESEEDING IN THE PRESENCE OF HETEROMYIDS

by

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STATEMENT BY AUTHOR

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ABSTRACT

Heteromyid rodents, the main granivores in southwestern deserts, selectively forage for large seeds. Therefore, I predicted that in habitats where these rodents are present, reseeding with small seeds should result in less predation than with large seeds. Small plots located in southeastern Arizona were reseeded with small and large seeds sown separately and together. Seed survival was monitored by sieving soil samples collected periodically until 36 days after planting. The number of small seeds removed by rodents was significantly lower ($p<.05$) than the number of large seeds removed within 3 days of planting, whether the seeds were planted separately or together. The rates of seed removal during the 36 day period were also significantly different ($p<.05$) for the different sized seeds whether planted separately or together. Thus, reseeding with small seeds can reduce predation by the heteromyid rodents living in this study area.

INTRODUCTION

Reseeding is a vital step in restoring depleted vegetation in a wide variety of habitats. Many reseeding projects fail because rodents eat the seeds. A variety of techniques for reducing the impact of rodents have been tested, but few have been highly successful. Most often resource managers use poisons to reduce rodent populations prior to reseeding, but this method is largely unsuccessful because of rapid immigration of new individuals (Sullivan 1979), and it has other obvious hazards. New methods of biological management could potentially be developed that use information gained from diet and behavior studies to reduce the destruction of seeds by rodents without attempting to eliminate the rodent population. Many studies show that certain rodents prefer particular species or sizes of seeds (Abbott 1962, Everett et al 1978, Gashwiler 1967, Lockhard and Lockhard 1971, Reynolds 1950, Reynolds and Haskell 1949, Smigel and Rosensweig 1974, Smith 1970). Thus, whenever alternative plant species are available that both meet the revegetation needs of the resource managers, and have seeds not preferentially foraged by the local seed-eating rodents, reseeding should be successful even with rodents present.

In southwestern deserts of North America, where range managers are attempting to restore rangelands depleted by overgrazing (Cox et al. 1982), rodents in the family Heteromyidae are the most important seed eaters (Brown, Reichman, and Davidson 1979). As early as 1950, Reynolds (1950) suggested that the influence of Merriam's kangaroo rats (Dipodomys merriami) on reseeding success depends on the size of seeds used. Brown and Davidson (1977; see also Inouye, Byers, and Brown 1980, Brown et al. in press) found that, as a group, all heteromyids selectively forage for the larger seeds relative to those available. In this study I tested the hypothesis that the fewer small seeds than large seeds would be removed by heteromyids. Plots in a semi-desert habitat were reseeded experimentally following all recommended procedures (Jordan 1981), using large and small seeds, separately and together. I compared the number of seeds surviving on 4 plots to the number of seeds surviving on a comparable plot which had been fenced to protect the seeds from rodents.

MATERIALS AND METHODS

The study area was on the Santa Rita Experimental Range located 45km south of Tucson, Pima County Az. The exact location was a slightly sloped 1-hectare area with a comoro soil type, at an elevation of 1300m. The dominant vegetation was a typical Sonoran desert-scrub, consisting of mesquite (*Prosopis juliflora*), burroweed (*Haplopappus tenuisectus*) and cholla (*Opuntia spp.*). Annual precipitation averages 355-432mm and is bimodal, with peaks in winter and summer.

Five experimental plots were prepared by removing the large shrubs by hand and plowing under small plants with a disc. Each of the 5 plots (see Figure 1a) was seeded with 6 15m rows, 2 each of 3 treatments: 1)small seeds applied at a rate of 175/m, 2)large seeds applied at a rate of 100/m, and 3)small and large seeds applied together at 88/m and at 50/m respectively. The treatment assigned to each pair of rows was randomly selected. The small seeds were blue panicgrass (*Panicum antidotale*), and weighed an average of 0.85mg each. The large seeds were barley (*Hordeum vulgare*), which weighed an average of 47.0mg each. The seeds were provided by the U.S.D.A., Soil Conservation Service, Tucson Plant Materials Center. All seeds were planted with a cone-seeder at a depth of 1-2cm on 21 June 1984, just before the expected beginning of the summer rains.

The control plot was protected from rodents with a rodent-proof fence similar to that used by Brown, Davidson, and Reichman (1979). The species of rodents present on the open plots were monitored by placing 100 live-traps at 10m intervals on and around the plots on the 5th and 6th night after planting. The traps were baited with mixed seeds and checked at midnight and at sunrise.

The number of seeds surviving on the plots was monitored by collecting soil samples from the rows immediately, 3, 9, 18, and 36 days after planting. One sample was taken from a randomly selected location in each quarter of every row each time. No samples were taken from the outer meter of any row because the cone-seeder applied seeds at a more variable rate at the beginning and end of each row. The samples, 2.5-3.5cm deep and 15 X 25cm in area, were taken lengthwise along the row. They were collected with the aid of a two-sided, fixed-area sampler and a trowel. The samples were placed in marked paper bags, returned to the lab, and dried in an oven at 50 c for 24h. The soil was then shaken through a series of Tyler sieves (#5,#10,#14,#18,#20,and #25) for 3 minutes. I counted the number of seeds remaining by examining the contents of each sieve , both dry and immersed in a saltwater solution, through a 10X viewing scope. Because blue panicgrass seeds

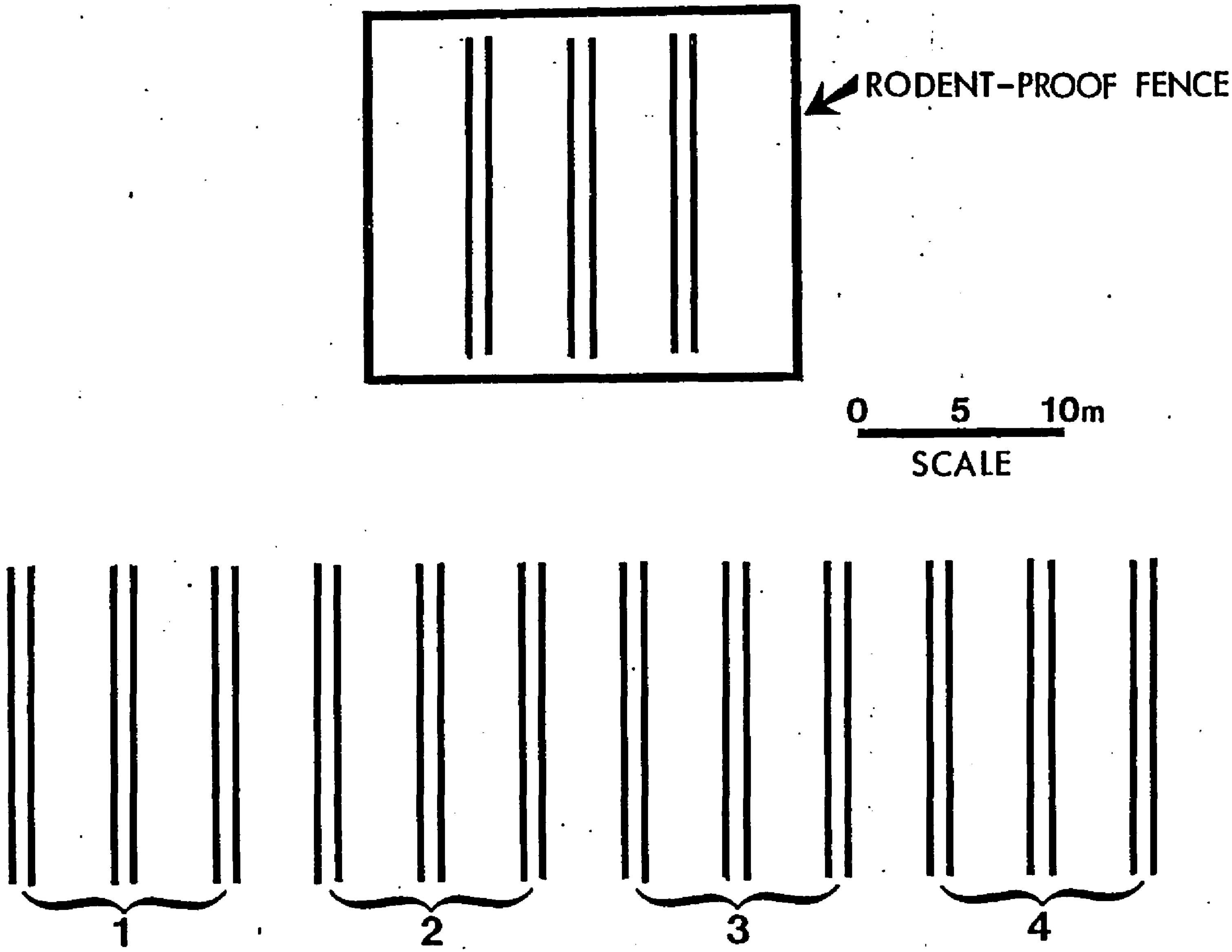


Fig.1 Experimental Plot Design

are very small and difficult to recover from the soil, I dyed them with a water soluble green food coloring before planting. To avoid a possible bias, the barley seeds were also dyed.

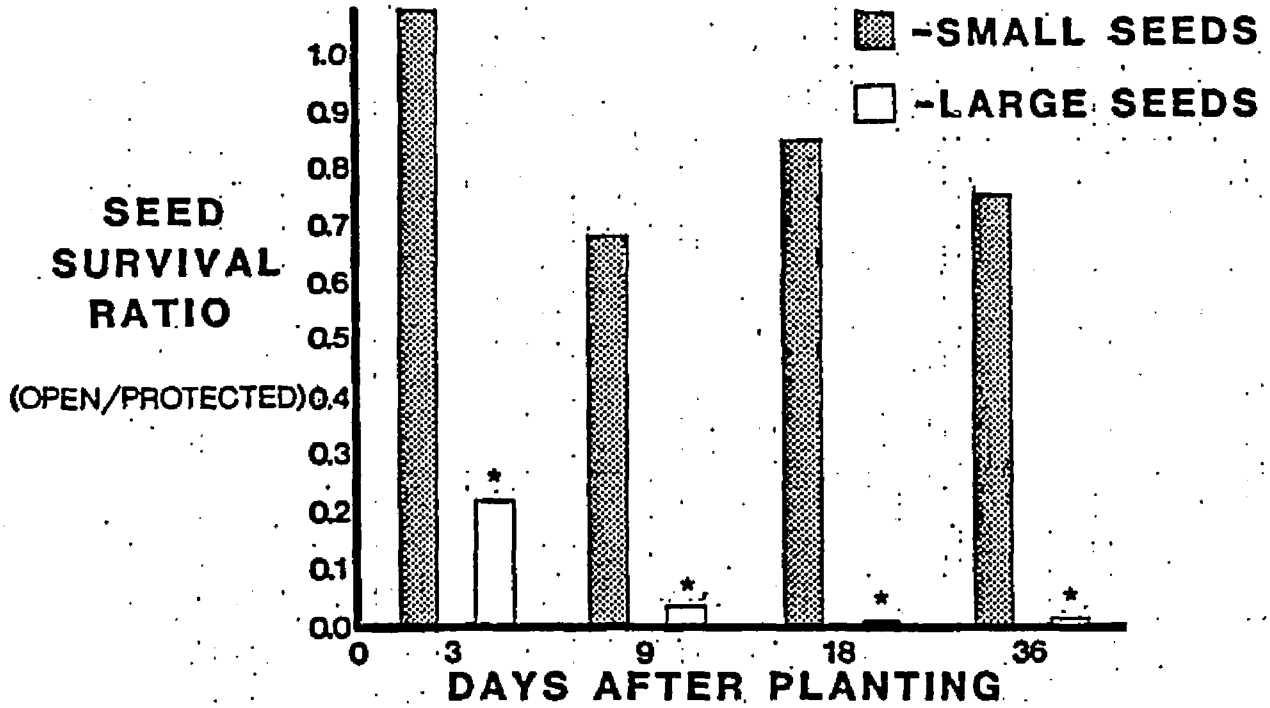
I used the ratio of the average number of seeds found in the 4 open plots to the number found in the protected plot as an indicator of the number of seeds removed by rodents. This dimensionless ratio permits comparison of the removal of the different sized seeds, even though they were planted at different rates, and it also standardizes for the experimental error contributed by the difficulty of recovering small seeds. I tested for significant differences between the seed survival ratios of the different sized seeds at each sampling using one-tailed T-tests.

To compare the overall rates of removal of the different sized seeds, I transformed the data to a natural log scale, and regressed the difference between the seed survival in each open plot and the seed survival in the protected plot as a function of the natural log of days after planting plus 1. I tested for significant differences between the rates of removal of large and small seeds using an analysis of variance and LSD mean separation tests.

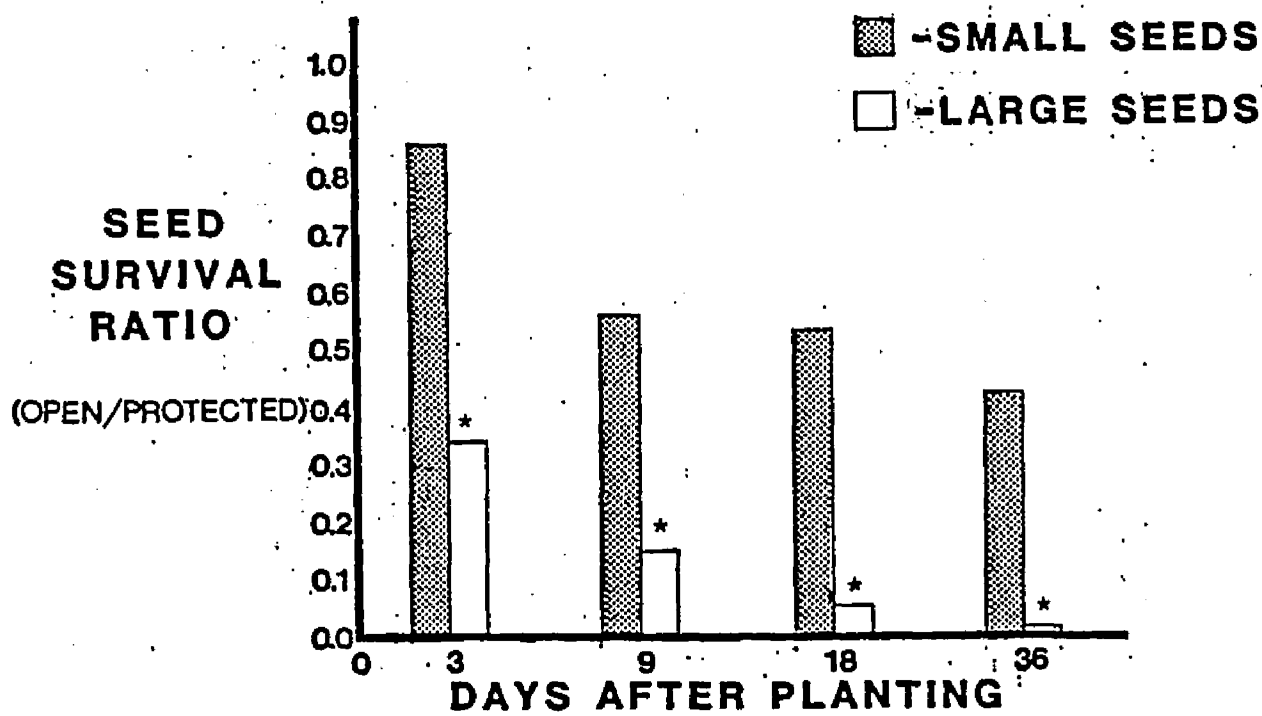
RESULTS

Eleven of the 17 individual rodents captured on or around the plots were heteromyids: 9 were Merriam's kangaroo rats, and 2 were bannertail kangaroo rats (*Dipodomys spectabilis*). Two white-throated woodrats (*Neotoma albigula*), 2 grasshopper mice (*Onychomys torridus*), 1 deer mouse (*Peromyscus maniculatus*) and 1 cotton rat (*Sigmodon hispidus*) were also captured.

When large and small seeds were planted separately or together, the relative number of seeds removed by rodents was significantly higher for large seeds than for small seeds at each sampling except for immediately after planting (Figure 2 and Appendix A). After 36 days, the large seeds planted separately and together were virtually gone from the open plots. The average number of small seeds planted separately remaining in the open plots after 36 days was only 23.5% lower than in the protected plot, and the small seeds planted with large seeds were 56.4% lower in the open plots. The average rates of removal of the different sized seeds are compared in Figure 4. The analysis of variance of the rates of removal of large and small seeds showed that there were significant differences between treatment means, and LSD separation tests showed that the rate of removal of



a) Seeds sown separately



b) Seeds sown together

Fig.2 Differences in Average Seed Survival on Open Plots and Seed Survival on Protected Plot. * - $p<0.05$.

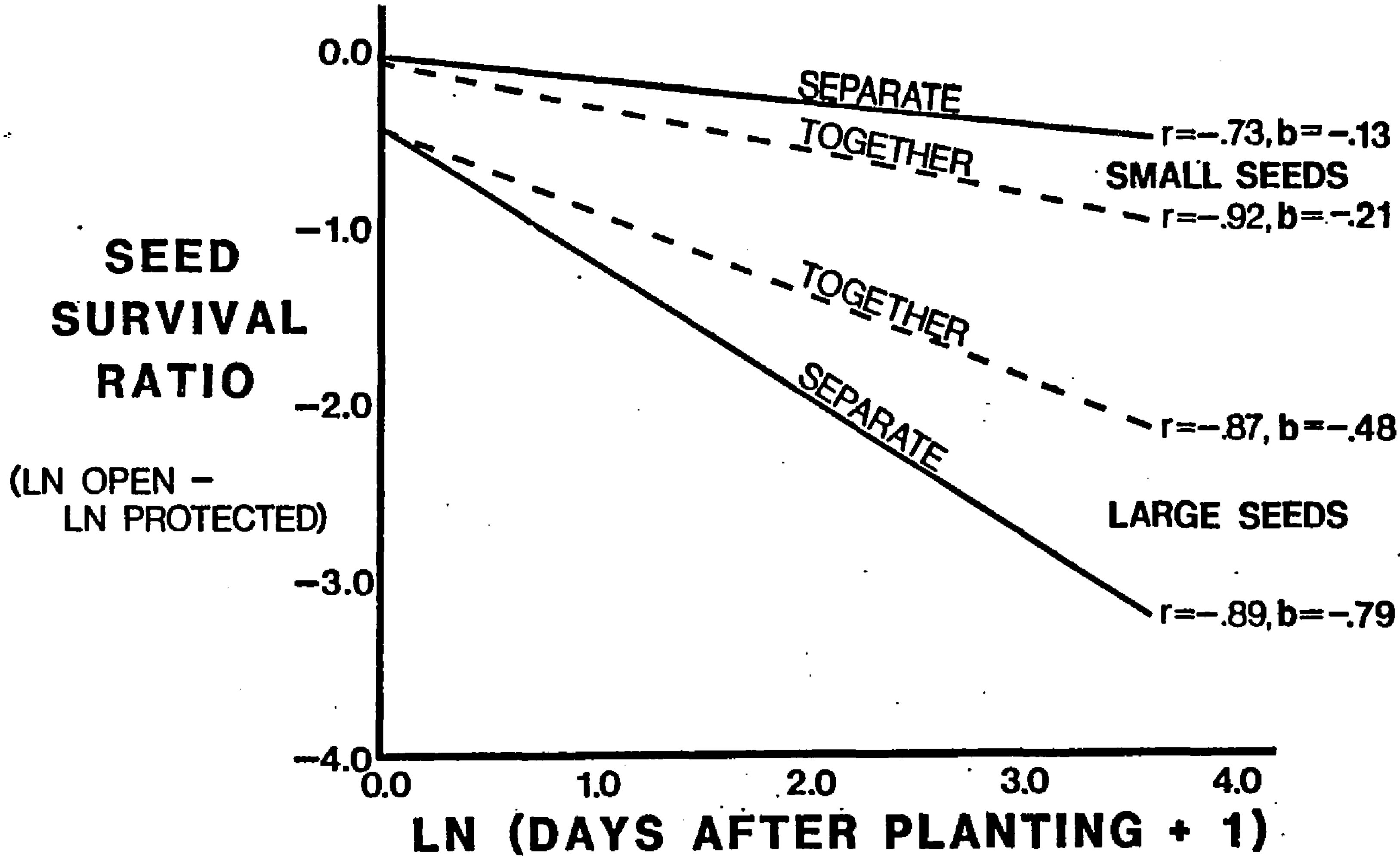


Fig.3 Average Rates of Seed Removal. LSD(.05)= 0.13.

Table 1 Analysis of Variance of Slopes of Ln(Seed Survival Ratio) as a Function of Ln(Time + 1).

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	Sig.
PLOT	0.00814	3	0.0027	0.408	0.7511
TRMT	1.09469	3	0.3649	54.896	4.15E-6
ERROR	0.05983	9	0.0067		
TOTAL	1.16265	15			

the small seeds was significantly lower than for the large seeds both planted separately and planted along with large seeds (Table 1). Consequently, I reject the null hypothesis that seed size had no effect on the number of seeds removed by the heteromyid rodents when large and small seeds are sown separately or together. In other words, compared to using large seeds, using small seeds greatly decreases the number of seeds removed by the heteromyids living in this study area. I can not explain why 9 days after planting there was a lower seed survival ratio than on 18 or 36 days, except for variability in seeding rate and sampling error.

DISCUSSION

The significantly higher rate of removal of large seeds planted separately compared to the large seeds planted along with small seeds is probably because the lower density of large seeds in the mixed rows makes them less attractive to rodents. The relatively higher rate of removal of small seeds planted with large seeds compared to the rate of removal of small seeds planted separately, however, is most likely because the large seeds attracted the rodents to the rows, where the rodents then ate both sizes of seeds. Sullivan and Sullivan (1982) observed the opposite effect when reseeding lodgepole pine (*Pinus contorta*): seed consumption by rodents could be reduced by planting the relatively small lodgepole seeds together with sunflower seeds, which are larger and more preferred by the granivorous rodents present. I can not explain the opposing results other than by suggesting that the rodents present in their study (*Peromyscus maniculatus*) may behave differently from the heteromyids present in this study.

There are certainly factors, such as percent soluble carbohydrates (Kelrick and MacMahon 1985), other than seed size that affect preferences by rodents for particular seed species. For most seeds, however, resource managers have only the information on size available. This study compared just the effect of size by using grass seeds of similar composition that differ most in their linear dimensions. These results support other data finding that heteromyid rodents forage preferentially for large seeds and reduce standing stocks of large seeds in the soil to a much greater extent than small seeds (Inouye et al. 1980), and should give resource managers good cause to consider the size of seeds when planting in areas inhabited by heteromyids.

APPENDIX A

SEED RECOVERY DATA

Number and variance of blue panicgrass and barley seeds found per sample (n = 8)

DAY	SEED	PLOT 1		PLOT 2		PLOT 3		PLOT 4		PLOT Protected	
		No.	s^2	No.	s^2	No.	s^2	No.	s^2	No.	s^2
0	BP	42.9	256.4	45.4	260.8	42.3	243.4	41.0	58.6	41.8	64.5
	Bar	24.3	83.4	25.4	107.1	29.5	84.3	22.4	73.4	23.0	39.7
	BP	19.3	112.5	19.4	39.4	23.4	95.4	20.4	87.1	23.3	76.5
	Bar	10.3	11.4	12.9	15.9	13.3	38.8	13.6	52.3	13.3	18.2
3	BP	40.0	114.6	45.4	97.4	39.4	337.7	41.4	360.6	39.5	305.1
	Bar	9.3	65.6	7.1	33.8	6.3	26.2	3.3	3.1	29.3	98.5
	BP	21.9	88.7	16.5	47.1	15.6	57.7	17.1	89.6	20.8	41.4
	Bar	8.3	40.2	8.3	31.6	1.9	1.9	1.5	3.7	14.0	23.7
9	BP	21.9	60.7	16.8	69.6	24.8	170.8	16.9	84.4	29.1	73.8
	Bar	2.5	6.3	0.6	0.6	1.0	0.9	1.3	7.6	27.3	26.8
	BP	17.0	78.6	7.5	27.1	12.3	39.4	6.3	35.9	18.6	94.0
	Bar	2.6	14.0	1.4	3.1	3.1	4.7	0.5	0.3	12.1	8.4
18	BP	23.4	59.4	23.1	179.6	21.3	193.1	15.8	169.1	24.1	68.7
	Bar	0.0	0.0	0.0	0.0	0.3	0.2	0.5	1.1	21.0	85.7
	BP	7.4	16.3	9.1	11.3	10.4	12.8	7.4	38.6	15.9	98.1
	Bar	0.1	0.1	0.4	0.6	1.8	5.1	0.0	0.0	9.0	45.7
36	BP	14.5	58.0	18.0	192.0	19.3	127.9	10.6	25.4	20.4	170.3
	Bar	----	-----	----	-----	----	-----	0.3	0.5	16.5	108.9
	BP	5.3	10.5	5.4	23.1	3.5	15.4	3.8	8.8	10.3	51.6
	Bar	0.3	0.5	0.1	0.1	0.3	0.2	0.0	0.0	7.3	28.8

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