Oak seedling establishment on California rangelands

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Abstract

Factors responsible for poor recruitment of blue oak (*Quercus douglasii* H. & A.) and valley oak (*Q. lobata* Neé) need to be determined on California hardwood rangelands so that management strategies for enhancement of recruitment can be developed. To examine selected factors, exclusive of large herbivore impacts, a series of acorn seeding experiments was initiated in 1985 in 6 counties on representative sites. At each site, the experimental treatments were the factorial combination of herbs vs. no herbs and screen protection vs. no protection. The experimental design was 4 randomized complete blocks of the herb treatments with each main plot split for the 2 levels of protection. Rainfall and edaphic factors were used to help interpret measures of seedling emergence, survival, and growth. Herbaceous plant control for reduction of moisture stress was the most important factor examined. Emergence was significantly improved by control in nearly 80% of blue oak seedlings and in 33% of valley oak seedlings. Average first year survival, expressed as a percent of acorns sown, was significantly improved with control in seedlings of both blue oak (33% vs. 18%) and valley oak (45% vs. 21%). Limited data suggest the difference in survival remains consistent over time as overall survival declines. With few exceptions, the addition of screen protection discouraged predation and significantly enhanced survival and growth. Window screen cages also may have contributed an unmeasured shade effect.

Key Words: *Quercus douglasii*, *Q. lobata*, competition, predation, protection, shade

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Fig. 1. Location of 7 oak-grassland sites in 6 counties where oak establishment from acorns was studied.

Clearing of noncommercial oak (*Quercus* spp.) woodlands in rangeland improvement projects and poor natural regeneration were 2 concerns identified by the Hardwood Task Force of the California Board of Forestry in its December 1983 draft report (Passof and Bartolome 1985). Since 1985, the loss of noncommer-

cial oak woodland in California is estimated to be excess of 400 thousand hectares of 16% of the 3 million hectares total (Bolsinger 1988). These losses result from rangeland clearing, road and freeway construction, and residential-commercial development. Limited data suggests the latter accounted for 46% of the annual loss (6,500 ha) between 1973 and 1985, surpassing the loss from rangeland clearing that dominated before 1973.

Loss of oaks is compounded by relatively sparse recruitment in blue oak (*Q. douglasii* H. & A.) stands, occupying about 1.2 million hectares or 40% of the oak woodlands, and almost nonexistent in valley oak (*Q. lobata* Nee) stands (Bolsinger 1988). Unsuccessful blue and valley oak recruitment results from mortality in seedling and sapling stages rather than from inadequate germination and seedling emergence (Griffin 1971). A study of age class survival suggests that the transition from a seedling to sapling and tree stages is more critical than acorn germination and early seedling survival (McClaran 1985). Development of restocking techniques and their relative efficacy are needed to preserve manage-

ment options for oak woodlands. We determined the influence of herbaceous competition and small mammal and insect herbivory on emergence, survival, and growth of seedlings developing from artificially sown acorns; and evaluated selected techniques for reducing negative impacts.

Study Sites

Over a 4-year period, successive acorn seedings were made on 8 sites—5 blue oak and 3 valley oak—at 6 locations; and 1 seeding of both oaks together was made at a seventh location (Fig. 1). All locations lie between latitudes 35° 15' and 39° 15' N (Fig. 1). These oak woodland sites in California's Mediterranean-like climate have understories dominated by annual grasses. Throughout the study area, annuals continue to grow until all available soil water is exhausted. A discussion of the ecology and composition of California annual grasslands is presented by Heady (1977).

The most southerly planting of valley oak was in Lopez Lake County Park (LPZLK), and that of blue oak was on the Canyon Ranch (CYNRN), both in San Luis Obispo County. To the north,

Table 1. Physical parameters at locations included in blue and valley oak seeding studies.

Location	Elevation (m)	Avg. annual precp. (cm)	Surface soil texture	Depth (cm)	Soils		
					Estimated AWC ¹ (cm/cm)	Soils series ²	Soil family
Blue oak							
University of California Hopland Field Station Mendocino County (HFS)	273	94	Loam	183	0.14–0.17	Hellman	Fine, mixed, thermic Mollic Palexeralfs
Sierra Foothill Range Field Station, Yuba County (SFRFS)	182	72	Gravelly loam	53	0.11–0.16	Argonaut	Fine, mixed, thermic Mollic Haploxeralfs
East Bay Regional Park District Briones Regional Park Contra Costa County (BRP)	188	48	Clay loam	86	0.15–0.18	Los Osos	Fine, montmorillonitic, thermic Typic Argixerolls
Private Landowner Jeff Schmidt Ranch San Benito County (SBNCO)	394	36	Shaly loam	61	0.10–0.14	Santa Lucia	Clayey-skeletal, mixed, thermic Pachic Ultic Haploxeralfs
Canyon Ranch, San Luis Obispo County (CYNRN)	545	28	Clay loam	155	0.14–0.17	Ayar	Fine, montmorillonitic, thermic Typic Chromoxererts
U.S. Forest Service Pacific Southwest Forest and Range Experiment Station, San Joaquin Experimental Range, Madera County (SJER)	333	48	Sandy loam	74	0.09–0.12	Ahwahnee	Coarse-loamy, mixed, Ultic Haploxeralfs
Valley oak							
University of California Hopland Field Station, Mendocino County (HFS)	273	94	Loam	152	0.14–0.17	Yorkville	Fine, mixed, thermic Typic Argixerolls
East Bay Regional Park District Briones Regional Park, Contra Costa County (BRP)	124	48	Clay loam	193	0.16–0.18	Botella	Fine-loamy, mixed, thermic Pachic Argixerolls
Private Landowner Jef Schmit Ranch San Benito County (SBNCO)	394	36	Shaly loam	61	0.10–0.14	Santa Lucia	Clayey-skeletal, mixed, thermic Pachic Ultic Haploxeralfs
County Park Lopez Lake County Park, San Luis Obispo County (LPZLK)	158	51	Sandy loam	183	0.10–0.15	Elder	Coarse-loamy, mixed thermic Cumulic Haploxerolls

¹AWC = Available Waterholding Capacity

²All are upland soils except Botella and Elder which are alluvial.

the 2 oaks were planted on the same site at the Jef Schmidt Ranch (SBNCO) in San Benito County. On the east side of the San Joaquin Valley in the foothills of the Sierra Nevada, blue oak was planted on the U.S. Forest Service San Joaquin Experimental Range (SJER) located in Madera County. In the San Francisco Bay Area, the 2 oaks were planted in Briones Park (BRP), each on a different site. The Park, part of the East Bay Regional Park District, is in Contra Costa County. North in the Coast Range, each oak was established on separate sites at the University of California Hopland Field Station (HFS) in Mendocino County. Above the Sacramento Valley, blue oak was planted on the University of California Sierra Foothill Range Field Station (SFRFS) in Yuba County. Elevation, rainfall, and soil characteristics (Table 1) represent conditions typical of those occurring in natural stands of the oaks found in the Coast Ranges, interior coastal ranges of the San Joaquin Valley, and western foothills of the Sierra Nevada in the Sacramento and San Joaquin valleys.

Methods

Acorns were collected from trees representing local ecotypes in late summer through early fall, dusted with captan, and placed in 0.08-mm clear plastic bags with material at the bottom to absorb excess moisture from respiration. The acorns were then placed in cold storage (4° C) until planting. Storage between 1°–4° C is recommended by Korstian (1927) and Harrington (1972) to retard germination without a reduction in emergence potential.

Plantings were made in late fall each year (November–December) from 1985–1988. Not all locations were included each year because local acorn production was irregular and sometimes inadequate for full execution of the experimental treatments.

Acorns were sown in open areas away from canopy effects and on terrain as flat as possible to reduce effects of slope exposure and inclination. All work was conducted within deer-proof enclosures to exclude browsing of seedlings by deer and livestock, an acknowledged problem (Franco 1976, Longhurst et al. 1979, Menke and Fry 1980) and to prevent depredations by feral pigs (*Sus scrofa* Linnaeus) where these animals may be a problem.

Treatments at each site included 2 levels of herbaceous plants (none and the naturally occurring vegetation) as main plots, and 2 levels of protection against small mammal and insect damage (screens and no screens) as a split on main plots. The experimental design was a randomized complete block with 4 replications.

Each main-plot replication consisted of 100 acorns planted in 4 rows of 25 each with 30 cm between acorns and rows. Planting depth was 5 cm, a depth suggested for use in controlled environments (Lobel and George 1983) and one considered a minimum to discourage disturbance by mice (Griffin 1971). This depth has been found to be a good compromise between improved protection from predation and reduced emergence that occurs from planting at a greater depth (Tietje et al. 1991). Acorns with obvious insect damage were discarded, and those that had germinated in storage were distributed among treatments and replicates to insure uniformity of potential emergence.

Germination in storage is a common problem. Prompt germination of blue and valley oak was identified as a characteristic by Griffin (1971). Matsuda and McBride (1989) were able to distinguish a differential between the 2 species, with germination of valley oak being slower and occurring over a longer period. This would explain why radicles appeared earlier and more frequently in our blue oak collections before planting.

During the study, 2 blue oak seedlings had to be replanted because of depredation. At CYNRN in 1985, feral pigs dug up many acorns before fencing was erected. In the second instance at SFRFS in 1987, deer mice (*Peromyscus maniculatus* Wagner) were the suspected problem. This assumption is based on live trap records at the site.

Measurement of emergence was confounded by small mammal depredations. Some acorns were destroyed early at all locations, both before and after emergence. One seeding at SJER was destroyed in 1985–86 and could not be reseeded. Ground squirrels (*Spermophilus beecheyi* Richardson) were possibly responsible. Subsequent seedings at SJER were made after the population was reduced, but control at this site was maintained throughout the study.

Table 2. Emergence (%) with and without herbaceous plant control in 13 blue and 9 valley oak seedings (1985–1988) and the associated precipitation patterns at: Canyon Ranch (CYNRN), Jef Schmidt Ranch (SBNCO), San Joaquin Experimental Range (SJER), Briones Regional Park (BRP), Lopez Lake County Park (LPZLK), Sierra Foothill Range Field Station (SFRFS), and Hopland Field Station (HFS).

Location	Seeding	Seasonal precip. (cm)	Avg. annual precip. (%)	Emergence			
				Blue oak		Valley oak	
				No herbs	Herbs	No herbs	Herbs
				----- % -----			
CYNRN	1985	33	118	72	75	—	—
	1987	27	96	64*	41	—	—
	1988	15	54	71*	15	—	—
SBNCO	1985	45	125	15*	4	81	88
SJER	1987	31	65	20*	4	—	—
	1988	33	69	59*	41	—	—
BRP	1987	37	77	—	—	72*	15
	1988	35	73	25*	1	84	87
LPZLK	1985	63	124	—	—	69	59
	1987	40	78	—	—	56*	34
	1988	43	84	—	—	55*	30
SFRFS	1985	86	119	78*	53	—	—
	1986	48	67	43	31	—	—
	1987	54	75	35	40	—	—
HFS	1986	62	66	60*	41	32	26
	1987	73	78	12*	0	86	75
	1988	68	72	29*	18	44	35
	MEAN			45*	28	64*	50

*Significant at the 0.05 level for each seeding and each species.

Pocket gophers (*Thomomys bottae* Eydoux & Gervais) were common at all sites, and control was practiced where populations were a significant threat. However, no level of control was adequate to prevent losses to this rodent. These depredations may have been encouraged by the geometric planting pattern and relatively close spacing of acorns.

Emergents in each main plot were randomly split into 2 groups, protected and unprotected, with protection provided by window screen cages (closed cylinders 15 cm in diameter and about 40 cm high) or Foregon® (formerly Vexar®) 14-strand rigid plastic seedling protectors (screens) 5 cm in diameter and 30 cm high. The large mesh plastic screens were substituted for window screen cages when the threat from grasshoppers (*Melanoplus devastator* Scudder) was minimal. As a consequence, the efficacy of this less expensive protection was evaluated in 6 seedlings, 2 blue oak seedlings each at CYNRN and SJER (1987 and 1988) and 2 valley oak seedlings at LPZLK (1987 and 1988). At all 3 locations, black-tailed jackrabbits (*Lepus californicus* Gray) and rabbits (*Sylvilagus* spp.) are the suspected major causes of browsing damage, and ground squirrels possibly are a threat at SJER. Protection was applied beginning in Spring 1987 to all 1-year seedlings and emergents in new seedlings.

Following 1986 emergence in the 1985 SFRFS seeding, hairnets used in the food processing industry were applied to seedlings to protect against defoliation by grasshoppers. In subsequent seasons, window screen cages replaced this temporary expedient.

During the 1985-86 growing season, glyphosate, a systemic herbicide, was applied after planting to control herbaceous growth until oak seedling emergence. After emergence, herbs were hoed. In subsequent seasons, initial herb control in new seedlings was obtained using both glyphosate and a soil active herbicide, atrazine, to eliminate existing herbaceous growth and such growth that might appear after application. The combination was used to reduce labor. In established plantings, 2 soil active materials, atrazine and oxyfluorfen, were applied annually during winter dormancy for more effective control of herbaceous growth. Potential for damage to emerging oak seedlings discouraged use of the latter chemical during the season of planting.

In 1 blue and 1 valley oak seeding, each planted in 1985 (CYNRN and LPZLK), herbaceous plant interference was eliminated in all treatments after the first season. This was necessary to provide access. A third seeding at CYNRN in 1986 was established only with control of herbaceous plants.

Data evaluated by analysis of variance (ANOVA) included emergence, survival measured in the spring of each growing season, and height of plants each fall. To increase the power of the analysis, data for each species were pooled in emergence and first-year survival analyses. When measuring height, the longest stem was used if branching occurred. Unless otherwise noted, significant differences are reported at the 95% level of confidence.

Use of height as an index of growth appears valid. First-season growth of screened blue oak in a concurrent study showed a highly significant ($P < 0.01$) correlation ($r = 0.75$, $df = 158$) between height and basal stem diameter. The equation for linear regression of stem diameter on height is $Y = 1.63 + 0.12X$.

Since data were collected over several time intervals, time was a third factor in survival and was considered a second split (Steel and Torrie 1960). When there was a significant time interaction, ANOVAs for each time interval were used to assess the treatment effects. This was done to insure a conservative interpretation of data.

When necessary for the ANOVA, raw data were transformed to maintained homogeneity of variances. The results presented are treatment averages for the original measurements.

Results

Emergence

Overall emergence of 13 blue and 9 valley oak seedlings was improved through herbaceous plant control (Table 2). Emergence of blue oak was improved 61% by control and that of valley oak showed an increase of 28% with this treatment.

Survival

Average first-year survival of both oaks was improved by herb control, and screens further reduced mortality among seedlings with protected emergents (Table 3). No interaction between the 2

Table 3. Effects of herb control and screen protection on oak seedling survival (percent of acorns sown) in the first year for seedlings made in 1986 and 1987 at: Canyon Ranch (CYNRN), Hopland Field Station (HFS), Sierra Foothill Range Field Station (SFRFS), Briones Park (BRP), and Lopez Lake County Park (LPZLK).

			Survival		
			Herb control		Mean effect of protection
Seedling		Screen protection	No	Yes	
----- % -----					
Blue oak					
CYNRN	1987	No	21	36	
		Yes	27	45	
HFS	1986	No	22	55	
		Yes	36	59	
SFRFS	1987	No	35	33	
		Yes	39	35	
Average Effects		No	26	41	34
		Yes	34	46	40**
Mean Effect of control			30	44**	
Valley Oak					
BRP	1987	No	14	62	
		Yes	14	72	
HFS	1986	No	3	11	
		Yes	18	28	
HFS	1987	No	38	69	
		Yes	70	83	
LPZLK	1987	No	18	42	
		Yes	12	34	
Average Effects		No	18	46	32
		Yes	28	54	41**
Mean Effect of control			23	50**	

**Means in each main effect pair for each species are different by LSD Separation at the 0.01 level.

factors existed, but their independent contributions to enhanced survival were highly significant ($P \leq 0.01$). In these seedlings, herb control increased blue oak survival by nearly half and more than doubled it in the valley oak. Screens had less influence, but their use increased survival 18% in blue oak and 28% in valley oak.

With and without herbaceous plant control, average first-year survival in all blue oak seedlings was, respectively, 33% and 18%. These values are significantly different ($P \leq 0.05$). For all valley oak seedlings, the respective values for the first-year survival are 45% and 21%, also significantly different.

Data on survival for 3 growing seasons with and without herbaceous plant control is available for the 1985 SFRFS blue oak seeding and, with herbaceous plant control only, for the 1985 LPZLK valley oak seeding. At the end of the period in the blue oak seeding, survival with herbs was only 4% of acorns planted, but with control, survival was significantly ($P \leq 0.05$) more, 32%. The

declines in survival showed no interaction with time, but both were highly significant ($P \leq 0.01$) the first 2 seasons and similar thereafter. In the valley oak seeding, survival decline followed a similar pattern; survival was 32% after 3 seasons, and no significant change occurred after the second season.

When growing with herb control, percent survival of blue oak seedlings protected by screens for 2 seasons was significantly higher ($P \leq 0.05$ to $P \leq 0.07$) compared with those unprotected (Table 4). Protection increased survival 20% or more.

Table 4. Effect of screen protection in 2 years on percent survival of blue oak seedlings growing with herb control. Each value is the average of 2 locations for seedlings of the same age. Screens applied in 1987.

Protection level	Year	
	Survival	
	1988	1989
	(%)	(%)
Screens placed in season 1 ¹		
Screens	50**	48*
No screens	44	40
Screens placed in season 2 ²		
Screens	35 ³	34 ³
No screens	30	28

*,**Values in column for this age class are significant at the 0.05 and 0.01 levels, respectively.

¹CYNRN 1986 and HFS 1986

²CYNRN 1985 and SFRFS 1985

³Values in column for this age class are different at the 0.07 level.

In the above analysis, seedlings made in 1985 at SFRFS and CYNRN were not protected with screens in the establishment year. Treatment of the SFRFS seeding was described in methods. Screens were not applied the first season to the CYNRN seeding because evidence of predation was absent. In the 2 seeded in 1986, HFS and CYNRN, protection was applied after emergence.

After 2 years, average survival in 1986 HFS blue and valley oak seedlings growing with all treatment combinations was greatest in the treatment combining herbaceous control and screen protection (Table 5). This treatment, different ($P \leq 0.05$) from all others, contained 6 times as many seedlings compared with the least effective

Table 5. Effect of 4 treatments in 2 years on percent survival of oak seedlings at HFS. Each value is the average of 1 blue and 1 valley oak seeding made in 1987.

Year	Treatment			
	Survival			
	Herbs and no screens	Herbs and screens	No herbs and no screens	No herbs and screens
	----- % -----			
1988	13A ¹	27AB	33B	43B
1989	7A	24B	29B	42C

¹Values for each year not followed by the same letter are significantly different ($P \leq 0.05$), and those for 1989 represent an interaction (herbs $\times$ screens).

treatment, herbs and no screens; and it produced nearly 50% more seedlings than the second best treatment, herb control and no screens. These differences resulted from an interaction between control and protection.

Growth

In the first season, average height was enhanced ($P \leq 0.01$) by each main factor (herbaceous control and protection). In 3 oak seedlings (2 blue and 1 valley), herbaceous control increased height

50% (7.1 cm vs. 4.6 cm), and screen protection increased height nearly 75% (7.5 cm vs. 4.3 cm). There was no interaction, but protection combined with control produced seedlings nearly 3 times as tall as those in the least effective treatment, no control and no protection. Respective heights were 8.8 cm and 3.0 cm, a highly significant ($P \leq 0.01$) difference.

Two seasons of growth in 1 blue oak seeding with all 4 treatments produced a highly significant ($P < 0.01$) interaction between control and protection as a result of the threefold increase in height of protected plants growing without herbs, 24 cm compared with 7 cm. In all blue oak plantings (4) providing data during the second season, there was an average twofold difference ($P \leq 0.01$) in height between protected (20 cm) and unprotected (10 cm) seedlings growing with herbaceous control. During the 2 years of measurement, height of seedlings in these 2 treatments doubled. This also was highly significant ($P \leq 0.01$) and represented an interaction between treatment and time.

Mortality among unprotected valley oak seedlings in 1 of 2 seedings available for measurement permitted limited evaluation of changes in growth over time under herbaceous control. In the first season, difference ($P \leq 0.05$) in height between levels of protection occurred. Average height for protected and unprotected seedlings was, respectively, 7.6 cm and 5.6 cm. In the second season, no difference was measured, but the average height reached by protected seedlings growing with herbaceous control was 37 cm, a highly significant ($P \leq 0.01$) increase.

Discussion

The highest emergence of blue oak was recorded during a season (1985–86) of above average rainfall (Table 2). At the locations of record (CYNRN and SFRFS), depressed emergence in the presence of herbaceous interference followed declines in annual rainfall. However, no clear pattern of overall emergence associated with rainfall was presented. We suspect that available soil water in combination with other factors, e.g., seasonal rainfall pattern, influenced emergence at these locations. At a more mesic site (HFS), overall emergence appeared inversely related to rainfall (Table 2). McClaran (1987) observed an inverse relationship between precipitation and blue oak emergence in seedlings at 2 locations in each of 2 years. Emergence was greatest in a year when average annual precipitation at the 2 locations was 75% of the expected and significantly less when the average was 190%. Mortality was attributed to damping-off fungus stimulated by high rainfall. Because droughty conditions prevailed throughout our study at most blue oak sites, the available water holding capacity (AWC) of soils may have affected emergence. For example, in 1988, it may have been a major factor contributing to the difference in emergence between SJER and CYNRN (Table 2). Although rainfall at SJER was greater than at CYNRN, emergence at CYNRN was much higher where AWC was 68% more. Under droughty conditions, Matsuda and McBride (1989) suggest early germination and establishment (rapid root elongation) of blue oak may be advantageous for effective use of soil water.

Among successive valley oak seedlings in our study, emergence at 2 of 3 locations was highest during the wettest season (Table 2). At 1 location (HFS), the decline in overall emergence followed the pattern of annual rainfall. However, no general pattern of emergence associated with rainfall was evident in these seedlings.

The value of herbaceous plant control was identified early in this study (Adams et al. 1987), but it is not a unique observation. Throughout the East, Midwest, and Canada, the benefits of controlling herbaceous vegetation to promote survival and growth of oaks and other hardwoods propagated naturally and artificially are well documented (Bowersox and McCormick 1987, Siefert and Fisher 1985, von Althen 1987). In California, Griffin (1971) dem-

onstrated that reduced precipitation in addition to annual grass interference greatly reduced blue and valley oak seedling establishment. This supports our observations.

The addition of screen protection in our study had the expected beneficial effect on survival. Griffin (1976) observed that depredation from small mammals and insects continued after removal of deer. In the eastern U.S., rodents are the chief obstacle to reproducing oaks from seeded acorns (Johnson 1979, Krajicek 1955). Grasshoppers, a principal predator at several locations in our studies, are favored by a cover of herbaceous plants that provides habitat for development and feeding (Linit et al. 1986). This probably contributed to greater damage among unprotected seedlings growing with herbaceous plants.

Only 46% of incident sunlight is transmitted through the screen (measured in $\mu\text{E} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$ by a quantum sensor). The shade produced probably contributed to the differential in survival and height between protected and unprotected plants. Crow (1988) observed that seedlings of northern hardwoods, including those of red oak (*Q. rubra*), in the central United States generally benefit from shade because it reduces water stress by moderating temperatures and evapotranspiration. Compared to less shade tolerant species, red oak has a lower respiration rate at low light levels that results in greater net dry weight gain in shade (Loach 1967). For hypothetical northern red oak environments, by Hansen et al. (1987) calculations for whole-seedling CO_2 assimilation are not statistically different at 30% or more of open sunlight. Total shoot weight of 5-to-7-year-old seedlings of 9 northern hardwoods grown in full sunlight and 45% of this did not differ significantly, but all grew significantly taller at the lower intensity (Logan 1965, 1966, 1973). In our studies, we believe the screens provide an element of protection against excessive transpiration such as that found beneath tree canopies and in other environments favorable to early growth of seedlings. That blue oak seedlings are tolerant of reduced sunlight beneath the screens is supported by data from other research in which the amount of sunlight transmitted did not significantly reduce net carbon gain (Kevin Rice, pers. comm.). In our study, the shade factor could not be separated from the effect of protection.

Conclusions

Control of competing herbaceous vegetation appears essential to achieve adequate emergence and first-year survival of blue and valley oak seedlings developing from seeded acorns. Limited data on longer-term survival suggest mortality increases over time and remains consistently higher with competition. Herbaceous plant control also appears to discourage pocket gophers by limiting food sources. Control or exclusion of this rodent is recommended in all plantings.

Screen protection significantly improved survival and growth of both oaks under all conditions. Window screen cages had the most value; they produced shade and excluded both small mammals and grasshoppers. These screens are recommended for all plantings.

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