Mortality of Velvet Mesquite Seedlings

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Introduction

RECENT years have seen an invasion of mesquite, *Prosopis* spp., on the range lands of the Southwest which in some areas has been at a phenomenal rate. In many cases this invasion has resulted in range lands becoming almost worthless for livestock grazing and has accelerated soil erosion.

Mesquite has appreciably extended its geographical range, and within this area has spread out from the drainage bottoms, which were its original habitat, to the ridges and mesa uplands. It is estimated that mesquite now occurs on at least 60 million acres in Arizona, New Mexico, and Texas.

Mesquite seedlings occur in great numbers during favorable years. For example, Fisher (1947) has reported over 1,200 young mesquite seedlings per acre in Texas, while in southern Arizona 416 new seedlings per acre were counted.

It is the purpose of this paper to present some of the findings on the mortality of naturally occurring young mesquite seedlings as a background for a better understanding of an attack on this serious range problem. This study is part of investigations being conducted by the Southwestern Forest and Range Experiment Station in cooperation with the University of Arizona under RMA Project RM:b-4 on ecology and physiology of undesirable range plants.

The study was conducted on the Santa Rita Experimental Range, about 30 miles south of Tucson, Arizona, where the mesquite invasion problem is represented. The study site is typical of much of the semidesert range in the Southwest covered with the tree form of mesquite.

[1] Maintained by the Forest Service, U. S. Department of Agriculture for Arizona, New Mexico, and West Texas, with headquarters at Tucson.

Experimental Procedure

Origin of Mesquite Seedlings Studied

During late July 1948 a considerable number of recently emerged velvet mesquite seedlings (*Prosopis juliflora velutina* (Woot.)) were found on the Santa Rita Experimental Range shortly after the start of summer rains. Only 16 per cent of the seedlings occurred under the crowns of seed-bearing mesquites, with the remainder being found in small, sandy washes and gravel fans and on the open, more porous soils. Many of the seedlings were in clusters ranging up to 13 seedlings per cluster. In each cluster the seedlings emerged from an area approximately 1 inch in diameter. An examination of several of these seedling clusters and data on population and food habits of the Merriam kangaroo rat by Reynolds and Glendening (1949) indicates that the caches of this rodent are important in the spread of mesquite. The numbers of July 1948 seedlings on this and similar sites were 22 per acre under cattle and rodent protection; 129 under cattle exclusion; and 269 under grazing by cattle and rodents. Seedling numbers on the above sites were in direct proportion to the number of the Merriam kangaroo rats which averaged 1.1, 1.5, and 3.5 rats per acre, respectively. Germination from these seed spots occurred at least over a period of two growing seasons as

evidenced by the presence of new and old seedlings from the same cluster and also the presence of sound seeds which had as yet not germinated (Fig. 1).

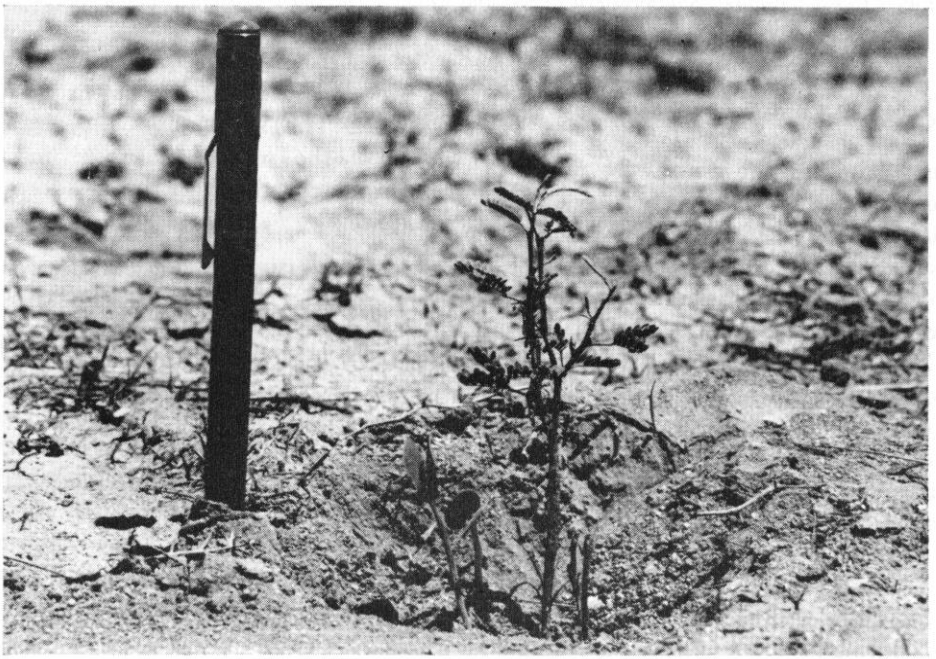

FIG. 1. Two recently emerged 1949 mesquite seedlings, one live 1948 seedling and two dead 1948 seedlings in one seed cache. Eight dead 1948 seedlings and six sound seeds were also found but are not shown in the photograph.

The area on which mesquite seedling mortality was studied is located at an elevation of 3,700 feet, and receives an average of 14.5 inches of annual rainfall. The surface soil is coarse and open and is underlain by a tight, rocky subsoil at approximately 16–20 inches.

On July 29, 1948, when the mesquite seedlings were 10 to 15 days old, 100 seedlings were staked out for observation under each of three conditions as follows: (1) protection from cattle and rodents, obtained by placing small cones of $\frac{1}{4}$-inch wire mesh over seedlings located within a cattle exclosure, (2) protection from cattle but subjected to yearlong rodent grazing as existed on seedlings within the cattle exclosure, and (3) no protection from cattle or rodents, as existed in the moderately grazed pasture in which the exclosure was situated.

At the time the seedlings were staked out, the following observations and measurements were made:

1. Number of seedlings per cluster
2. Height of the tallest seedling
3. Evidence and cause of grazing damage
4. Perennial vegetation within twelve inches of the seedlings
5. Distance to base of nearest seed-bearing mesquite

Subsequent observations were made on all seedlings at weekly intervals through September 1948, and monthly observations after that time.

Measurements of root and stem lengths were made five times during the 15 months the seedlings were under observation. These measurements were made at

times when the seedlings had just completed a critical period in their growth cycle, when an appreciable difference might be expected in the root and stem lengths. Root lengths were obtained by excavating seedlings of the same age located adjacent to those followed in the the study.

Pertinent Findings

Mesquite seedling mortality begins shortly after germination and emergence, which follows soon after the start of effective summer rains. By the end of the first two growing seasons, the large majority of mesquite seedlings were eliminated (Fig. 2). It was impossible to determine the specific cause for each loss because grazing and drought damage often occurred coincidentally on the same plant. However, rodent grazing appeared to be the main cause in these high initial losses since many of the seedlings lost either were entirely removed or had been cut off at the ground level. At this time the plants are green and succulent and are sought out by the rodents in the area. Leaf cutting and feeding by ants and other insects also occur at this time.

The effect of rodent grazing in reducing mesquite seedling numbers is readily seen by a comparison of the mortality curves (Fig. 2). While the early loss of seedlings in the cattle protected area was much less than on the area open to grazing, in both cases mortality of the seedlings at the end of the second growing season amounted to about 95 percent. The lower mortality rate under cattle protection is due to a lesser degree of rodent pressure rather than elimination of the cattle grazing factor. Mortality of seedlings under total protection, however, was considerably lower throughout the entire period of study and more than

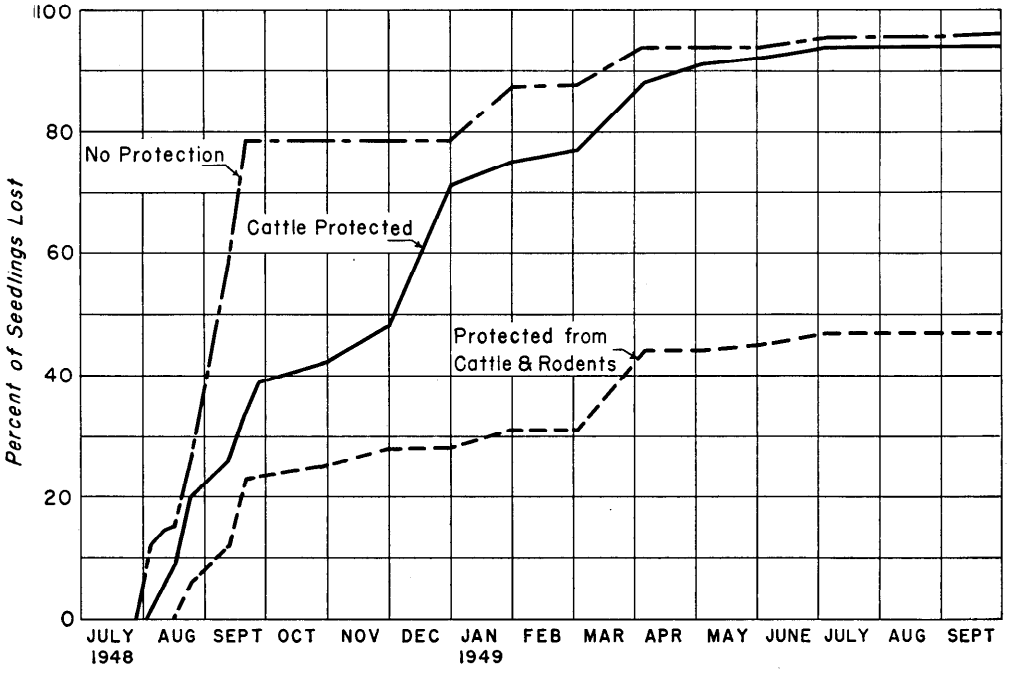

Fig. 2. Cumulative mesquite seedling mortality from August 1948 through September 1949 under three levels of protection.

half survived the second summer. Seedling mortality by this time is believed to have reached the maximum and will level off at approximately 47 percent under protection from cattle and rodents, 94 percent under cattle protection, and 96 percent under open grazing.

The above data on mortality when viewed in light of the emergence of 22, 129, and 269 seedlings per acre, as reported by Reynolds and Glendening, indicate that the ultimate rate of establishment of mesquite seedlings could be in the order 12, 8, and 10 per acre on areas protected from cattle and rodents, protected from cattle only, and on areas open to grazing by cattle and rodents.

Drought and unusually low winter temperatures during the period the study was in progress doubtless contributed to the high seedling losses. Rainfall during July of 1948 was 23 percent above the long-time average. This plentiful moisture brought about germination of mesquite seeds which, since the 1948 spring bean crop did not mature, must have been stored in the soil at least since 1947. During August, however, only 48 percent of the average precipitation fell. As a result many of the seedlings began showing signs of wilting within three weeks after emergence. Losses continued high until rains occurred late in September at which time the mortality rate generally leveled off under all degrees of protection (Fig. 2).

Seedling losses were low in October and November but increased during the winter months. The seedlings dropped their leaves in December and appeared to have hardened off. A low temperature of 15°F. in January resulted in additional losses from frost heaving under all degrees of protection. Climatic data show such a low temperature only once in the last 16 years, and losses from frost heaving are believed to be unusual on mesquite.

Additional seedling losses occurred with releafing in the spring. Rodent and insect grazing is believed largely responsible. Some plants recorded as having died in the spring probably died sometime earlier but unless there was clear evidence of death, the plants were carried on the records as living until they failed to leaf out in the spring and the loss was definite. Since these losses during the spring of 1949, there has been very little change in numbers surviving. Occasional losses occurred through the summer of 1949, evidently from a combination of grazing and drought. By this time, however, the seedlings were sufficiently well established to withstand any grazing short of actual decapitation below the cotyledonary node, and the root system had developed enough that complete drought kill was not common.

TABLE 1

Stem and root lengths of mesquite seedlings at the end of critical seasonal growing periods

PERIOD	STEM LENGTH	TAP ROOT LENGTH
	inches	*inches*
Initial Measurement (July 29, 1948)	2.2	3.7
End of First Summer Growing Period (September 1948)	2.2	15.0
End of Winter (March 1949)	2.0	20.6
End of Dry Spring (June 1949)	2.2	22.2
End of Second Summer Growing Period (September 1949)	3.0	27.1

As shown in Table 1, growth of the above-ground portion of the mesquite seedlings was slow throughout the entire year. Observations indicated that this is the usual behavior on semidesert ranges during drought periods. After an initial rapid elongation of the hypocotyl and stem, very little additional above-ground growth was made during the first growing season. Root lengths did increase

appreciably, however, throughout the period. Excavation of representative seedlings only 3 weeks after emergence showed that tap roots averaged 13.1 inches in length (Fig. 3). This rapid elongation of the tap root immediately following germination is probably important in the successful establishment of the seedlings which survived. Measurement of the root systems in late September 1948, showed tap roots to be 15.0 inches in length with very little lateral development. At the end of the second growing season many lateral roots were found. These originated about 12 to 14 inches below the surface of the soil. Tap roots at this time had penetrated to a depth of 27.1 inches.

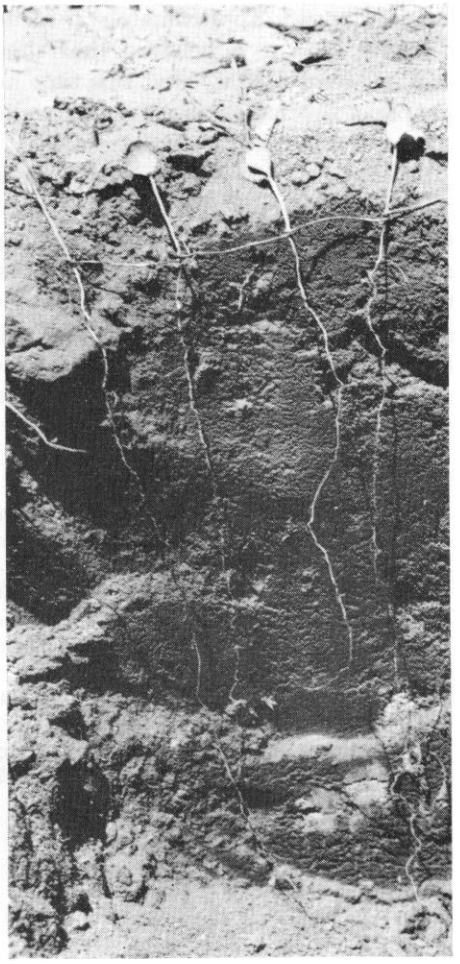

FIG. 3. Mesquite seedlings excavated three weeks after emergence. Tap roots average 13.1 inches in length.

When the seedlings leafed out in the spring of 1949, dieback to the first node below the terminal bud was noticed in almost all cases. This resulted in the formation of several new branches from lateral buds. Fisher, Fults, and Hopp (1946) have reported multiple branching of honey mesquite trees following severe frost injury in Texas. Grazing, drought, frost, or other factors which result in dieback will lead to the development of velvet mesquite seedlings with more than one main stem. These factors, operating in the past, doubtless account in part for the presence of many of the multiple-stemmed trees now present in southern Arizona.

There was no difference in seedling survival or mortality associated with proximity of other perennial vegetation, which consisted primarily of scattered burroweed; the distance to the nearest plant averaging 7.8 inches for both surviving and eliminated seedlings. Losses of single seedlings were 77 percent. In seedling clusters of 2, 3, and 4, losses were 64, 80, and 67 percent, respectively. This would seem to indicate that under the conditions of this study neither inter- nor intra-specific competition was as important in causing seedling loss as were the factors of rodent grazing and the generally low soil moisture conditions during the study.

Despite a high rate of mortality through the first two growing seasons, enough well established seedlings remain to increase the mesquite stand at the rate of at least 8 trees per acre per year. An annual increase of this magnitude for comparable range sites would rapidly

intensify the mesquite problem and is cause for even greater concern when it is realized that the rate of increase will become progressively larger as new trees reach seed-bearing size.

Summary

The mesquite invasion of range lands in the Southwest has progressed rapidly in spite of a high rate of seedling mortality. A study of some of the factors affecting the mortality of velvet mesquite seedlings which emerged during the summer of 1948 on the Santa Rita Experimental Range showed that at the close of the second growing season, seedling mortality was 96, 94, and 47 percent under the following levels of protection: open to yearlong grazing by cattle and rodents, cattle exclusion, and protection from cattle and rodents.

Grazing by several species of native rodents present on the area was the most important factor in eliminating mesquite seedlings during the first two growing seasons. Previous work has shown that one of these, the Merriam kangaroo rat, helps to disseminate the seeds and is associated with the occurrence of great numbers of mesquite seedlings.

Subnormal rainfall, especially during the first summer growing season, and unusually low winter temperatures which occurred during the study period, were also important factors which contributed to the high mortality rate.

After two growing seasons, tap roots had developed to approximately 27 inches in length, and it is believed that those seedlings remaining alive at this time are capable of surviving subsequent droughts and developing into mature trees.

The increase in the mesquite stand which would result from the successful establishment of the remaining seedlings as shown in this study would be not less than eight trees per acre per year. As additional trees reach seed-bearing size, the rate of increase may be expected to become progressively more rapid and to intensify the problem even further.

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BRIEFS

The Arizona Cattlelog, of the Arizona Cattle Growers Association, goes contrary to a popular trend with this advice: "The best place to find a helping hand is at the end of your own arm."

The success of ranching is in relation to the degree you practice selective neglect.—J. Bruce Orcutt, Miles City, Montana.