

# Cultural Practices for Grain Sorghum Production Through a Cotton Bur Mulch

*The authors of this article report that a thick mulch of cotton burs on the soil surface is an effective means of reducing soil salinity to a level that permits return of barren, saline soils to production. However, with such a mulch certain modifications in method of seeding are necessary, for sorghum seedlings cannot push through the heavy mulch.*

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**T**HICK surface mulches aid in the reclamation of saline soils by slowing the upward and enhancing the downward movement of salts (1, 2). Such mulches reduce the evaporative loss of soil moisture, lower the soil temperature, and reduce runoff.

Mulches of several types have been used for soil moisture conservation for many years (3, 4). Usually, thick, organic mulches used for moisture conservation purposes are plowed under before crops are planted. Where thick mulches are applied to aid in the reclamation of saline soil, it would be beneficial to crop the soil with the mulch in place and thus obtain some return during the latter phases of reclamation (1, 2).

Reported in this article are the findings from a study designed to determine if grain sorghum could be produced on initially saline soil with a 2- to 3-inch-thick cotton bur mulch in place on the soil surface. The usefulness of a permanent ridge-furrow system on saline soils was investigated simultaneously. Since salts are leached from beneath furrows in such a system (2), we thought that grain sorghum could be grown in the furrows.

## Location and Treatment of Plots

The investigation was conducted in a nonirrigated area in the Lower Rio Grande Valley of Texas on the saline phase of a Raymondville clay loam. The experimental plots were wide enough to accommodate

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eight 32-inch rows (approximately 25 feet) and extended across the saline area. All yield and salinity measurements were made in those portions of the plots where the initial electrical conductivity of the saturated soil extract (5) exceeded 7.0 mmhos per cm in the surface 2 feet at the time the plots were established. Generally, only salt tolerant crops can be grown at salinity levels exceeding 7 mmhos per cm.

Three treatments, designated as conventional tillage, mulched, and permanent bedding, were tested in the study. On the conventional tillage plots, the tillage practices employed were those commonly used by farmers in the area. The mulched plots received 20 tons of cotton burs per acre each August. The cotton burs were spread over the soil surface to form a mat about 2 inches thick after settling. Tillage was minimized on these plots to avoid disturbing the mulch. The permanent bedding plots were formed with a lister that produced ridges 38 inches apart. The ridge tops were about 6 inches above the furrow bottoms, and the ridges and furrows were maintained in place throughout the study. The sorghum was seeded in the furrow.

The grain sorghum variety used on all the plots in this study was RS-610, a hybrid adapted to the area.

## Soil Analyses

A complete series of soil samples from various depths was taken and analyzed in August 1962 when the plots were established; subsequently samples were taken and analyzed at periodic intervals to assess soil salinity and ionic composition.

The ionic composition of the soil solution was nearly uniform throughout the experimental area at the beginning of the study. The predominant cation was  $\text{Na}^+$ , which accounted for about 70 percent of the cations present. The predominant anion in the upper 24 inches of soil was  $\text{Cl}^-$ ; below that depth,  $\text{SO}_4^{2-}$  predominated. The cation exchange capacity of the soil averaged about 21 me per 100 g, and the exchangeable Na percentage ranged from 23 to 33 percent. The available moisture was about 2.4 inches per foot of soil. The elec-

trical conductivity of saturated soil extracts from different plots ranged from 9.22 to 18.43 mmhos per cm.

## Results of 1963 Trials

Conventional sorghum seeding equipment was used to plant the grain sorghum in February 1963. The shoe of the equipment opened a narrow strip of mulch above the seeding row and made a shallow furrow in the soil. After the seed was deposited in this furrow, the drag chain on the equipment dragged the mulch back into its original position. Thus, a continuous mulch was maintained on the surface.

The sorghum stand was poorest on the mulched soil. Since the salt level was lowest on the mulched soil, we began to look for reasons other than salinity for the unsatisfactory stand. Careful examination revealed that seeds germinated beneath the thick mulch, but seedlings died before they could push through the mulch cover. It appeared that the cotton bur mulch exerted mechanical resistance to seedling emergence.

A greenhouse pot study confirmed our preliminary conclusion. We found that the mulch offered mechanical resistance to emerging seedlings because of its matting characteristics, which derive from the cotton fiber it contains. The same problem likely would not occur with other mulching materials.

A period of severe drought occurred after the sorghum was planted in February 1963. Only 0.41 inch of rain fell between February 1 and May 1. No grain matured, except for a few scattered plants on the mulched plots where moisture losses were low. If a satisfactory stand had been obtained on these mulched plots, a crop of grain might have been produced.

## Results of 1964 Trials

In 1964, the drag chain was removed from the seeding equipment so that the narrow strip of soil uncovered by the seeding shoe was left unmulched. This seeding technique eliminated matting of the mulch over the seed, which had caused the problem of mechanical resistance to seedling emergence during the previous year.

By using the new seeding technique, a satisfactory sorghum stand was obtained on the mulched soils. A few plants emerged in the furrows on the permanently bedded plots, but the stand was extremely sparse. The salinity level beneath the mulch was favorable for sorghum production but that beneath the furrows was only moderately favorable. No seeds germinated on the conventionally tilled plots because of high salinity levels.

During the 1964 growing season, severe weed control problems were encountered. Conventional weeding equipment was not satisfactory for use on the mulched or the permanently bedded soils. Sweeps similar

to those used in stubble-mulch farming proved satisfactory for weeding the mulched plots, but no satisfactory technique was found for mechanically cultivating and weeding the permanently bedded soils. It is possible that chemical weed control could be employed, but it may not be feasible on permanently bedded soils because continued vehicular traffic on the established beds would cause compaction problems.

Rainfall during the 1964 growing season was 9.82 inches, of which 6.83 inches fell in May. Plants that survived a February 24 to April 14 rainless period had sufficient moisture thereafter. Grain sorghum matured only on the mulched plots. When harvested in June 1964, these plots yielded an average of 2038 pounds of sorghum per acre. The test weight of the grain was 51 pounds per bushel.

#### Discussion of Findings

This study shows that barren, saline soil can be brought back into production

by applying a thick surface mulch and farming the land with the mulch on the surface. Crop production with the mulch on the surface requires that special weeding and seeding practices be used. Nevertheless, it is eminently more sensible to employ special practices and grow crops than it is to till barren, saline soil and obtain nothing, as was the case on the conventionally tilled plots included in this study.

Perhaps improved weeding and cultivation techniques could be employed to produce grain sorghum on permanently bedded soil. This would be desirable, for permanent bedding does enhance salt leaching from beneath the furrows. However, because the furrows on the bedded plots included in this study were bare, salt reaccumulated in them when the rate of evaporation was high. This did not happen on the mulched soils, for once sufficient rain (only a few inches were required) had

leached the salt from beneath the thick mulchs, it did not reaccumulate.

The special tillage practices necessary to maintain the mulch in place can be performed with readily available equipment and these practices are equally as satisfactory for tilling unmulched, non-saline soil as they are for tilling saline areas. An additional advantage of the mulch is its moisture-conserving effect.

The primary disadvantage of mulches is that it is expensive to haul and spread them on the soil surface. It is possible that after an initial mulch application has aided in the reclamation of a saline soil, at least part of the subsequent mulches could be grown in place and shredded onto the soil surface. Because they often occur within non-saline fields, saline soils generally are tilled with the surrounding soils. Therefore, a practice to bring them back into production must be a practical one that can be readily applied under field conditions. Thick mulches maintained on the soil surface constitute such a practice and are effective means of returning barren, saline soils to production.

#### Summary

Grain sorghum was grown on originally saline soil with a cotton bur mulch on the soil surface to aid in reducing the salinity level. Conventionally tilled and permanently bedded plots were established for comparative purposes. Stubble-mulch ty sweeps were used on the mulched plots to avoid excessive disturbance of the mulch. A narrow strip directly above the seed row was left unmulched after planting to prevent the mechanical resistance to seedling emergence exerted by the cotton bur mulch. Grain yields on the mulched plots averaged 2038 pounds per acre. In contrast, neither conventionally tilled nor permanently bedded soils produced grain even though salt concentrations were reduced beneath the permanent furrows.

#### REFERENCES CITED

1. Carter, David L., and Carl D. Fanning. 1964. *Combining surface mulches and periodic water applications for reclaiming saline soils*. Soil Sci. Soc. Am. Proc. 28: 564-567.
2. Fanning, Carl D., and David Carter. 1963. *The effectiveness of a cotton bur mulch and a ridge-furrow system in reclaiming saline soils by rainfall*. Soil Sci. Soc. Am. Proc. 27: 703-706.
3. Gerard, C. J., M. E. Bloodworth, and W. R. Cowley. 1959. *Effect of tillage, straw mulches and grass upon soil-moisture losses and soil temperature in the Lower Rio Grande Valley*. Misc. Paper 382. Texas Agr. Exp. Sta., College Station.
4. Hanks, R. J., and N. P. Woodruff. 1958. *Influence of wind on water vapor transfer through soil, gravel and straw mulches*. Soil Sci. 86: 160-164.
5. United States Salinity Laboratory Staff. 1954. *Diagnosis and improvement of salt and alkali soils*. Agr. Handbook No. 60. U. S. Dept. Agr., Washington, D. C.

Typical experimental plots under the three different treatments on highly saline soil as they appeared in June 1964. Grain sorghum was planted on all the plots in February 1964. (Top) Conventionally tilled plots produced only a few salt tolerant weeds. (Center) Permanent ridge-furrow plots presented serious problems of weed control and produced no grain. (Bottom) Cotton bur mulched plots produced a good crop of sorghum.

