UNIVERSITY OF CALIFORNIA PUBLICATIONS

COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
BERKELEY, CALIFORNIA

SWEET SORGHUMS FOR FORAGE

BY
B. A. MADSON

BULLETIN No. 293

APRIL, 1918

UNIVERSITY OF CALIFORNIA PRESS
BERKELEY

1918

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SWEET SORGHUMS FOR FORAGE

By B. A. MADSON

At no time in the history of California has the demand for forage crops been as great as now. The California farmer realizes that if he is to contribute materially to the much needed supply of meat, he will have to depend more upon forage crops and less on natural range in order to finish his animals for market as quickly as possible. The dairy farmer too is cognizant of the fact that forage and especially silage is essential to the success of the dairy industry. For these purposes crops are required which can be depended upon to produce relatively large amounts of feed during the summer months. The crops which thus far have shown the greatest promise in filling this need are the sweet or saccharine sorghums. Their special value lies, not only in their drouth resistance, and adaptation to California conditions, but also in the fact that they fit well into the cropping scheme on the general livestock farm, and may be used in the ration in a number of ways. One of the important uses to which sorghums may be put is as stock feed in the form of silage. For this purpose Woll and Voorhies have shown that on the basis of dry matter, sorghum silage compares favorably with Indian corn in feed value.¹ Sorghums may also be used as fodder and because of their leafy character and succulence, yield a palatable and nutritious roughage. Under certain conditions, the sorghum may also be used for hay or pasture. For this purpose, however, sudan grass, because of its greater persistence and finer leaves and stems, is usually to be preferred.

ADAPTATION

Like other members of the sorghum family, the sweet sorghums prefer a rather dry, semi-arid climate, with high temperatures during the growing season. They will, however, tolerate lower temperatures and a greater degree of humidity than either the grain sorghums or sudan grass. In general, it may be said that any climate that is suitable for Indian corn is also suitable for the sweet sorghums. In addition, the sorghums have the advantage of being much more tolerant of drouth than Indian corn.

¹ Univ. Calif. Agr. Exp. Sta. Bul. 282.

Their ability to withstand drouth is apparently due to their faculty of making economical use of the water supply as well as the ability to remain partially dormant for prolonged periods without injury. The root system of the sorghum is well developed, enabling the plant to utilize a larger portion of the soil moisture than most other plants. It is this ability to make the fullest use of the moisture and to regulate its growth in accordance with the supply of moisture, that makes the crop of special value in this state.

The soil requirements of the sweet sorghums are practically the same as those for Indian corn. Free working, sandy loam soils of good water-holding capacity are preferred to heavier soils, because of their high fertility, better aeration, and the greater ease with which they can be handled. Soils of this character are usually warmer, facilitating prompt germination and rapid root development. Other types of soil may be used, however, provided due precaution is taken with regard to the time of planting and the preparation of the seed bed.

In general the sweet sorghums can be grown in practically all agricultural sections of California, with the exception of those directly exposed to the cold ocean winds. The larger valleys, with their high temperatures, and deep, fertile, well drained soil, are particularly suited to this crop. As a source of fodder and silage, they are the most promising of any crop at the farmer's command.

VARIETIES

The sweet sorghums are closely related to the grain sorghums and broom corn, as well as to sudan, and tunis grass. They are particularly characterized by the fact that the sap contains a higher percentage of sugar, which renders them of considerable value for syrup making. The sugar content as well as the juiciness of the stem varies with the variety; so much so, in fact, that the line of demarcation between the sweet sorghums and the kafirs can not be clearly drawn. As a class, however, the sweet sorghums are much more succulent and leafy than the grain sorghums, while their seeds are small and hard and only of little value for feed. The sweet sorghums as a class stool or tiller more abundantly than the grain types.

Of the large number of varieties introduced into or developed in this country, only a few have attained wide agricultural importance. Only the more prominent of these or the ones which have been grown in this state will be discussed in this publication.

The oldest, as well as the most widely grown variety in this country is the Early Amber. Its earliness permits its growth in regions where the growing season is too short for other varieties. Early Amber is characterized by rather slender stalks, varying in height from six to ten feet, and loose open heads or panicles with black glumes enclosing the seeds. Selections of the Early Amber known as Dakota Amber and Minnesota Amber are also being grown to some extent, but in their general character and adaptation they differ but little from the parent type.

Fig. 1.—Honey sorghum under irrigation at the University Farm, Davis. This variety gives good yields of excellent forage. Note the dense growth of slender leafy stalks.

Red Amber sorghum is similar to the Early Amber, except that it makes a little larger growth, is a little later maturing and has red glumes or chaff instead of black. At present it is grown only to a limited extent, though it possesses distinct advantage over this former variety as a forage crop.

Honey sorghum is a selection from one of the earlier introductions and has been regarded with special favor for syrup purposes. It produces slender leafy stalks, varying in height from eight to twelve

feet. The heads or panicles of this variety resemble somewhat the Red Amber, though they are usually smaller, are less spreading, and have yellowish brown glumes. It is medium late maturing and has decidedly tender stalks, which is particularly important from a forage standpoint.

The orange sorghum like the Honey is medium late maturing, but has rather stout stalks with long internodes and broad, though less abundant leaves. The plant varies in height from eight to twelve feet, but its stalks are much less tender than those of the former variety. The seed heads of this variety are heavy and quite compact, resembling somewhat a head of kafir. The glumes or chaff are red and black at maturity, while the seeds are reddish yellow in color and protruding.

Sumac, commonly known as Red-top sorghum, is a late-maturing variety, with rather stout stalks and an abundance of leaves. Its seed heads are erect, cylindrical and compact. The seeds are small and reddish brown in color, and protrude beyond the glumes. The glumes also are very small, varying from deep red to black in color. The red color of the head which has given rise to the name "Red-top" is due to the red color of the seed. The plant varies in height from eight to twelve feet and is an excellent variety when the growing season is long enough to permit its maturity.

Goose-neck is one of the older varieties in this country, and is particularly characterized by its pendent or goose-neck heads. During recent years, seed of this variety has been put on the market under the name of "Texas Seeded Ribbon Cane." It is the largest of all varieties, varying in height from ten to fourteen feet, and is extremely late maturing. The heads of the Goose-neck sorghums are rather thick and brushy, with shiny black glumes which completely enclose the seed. In the section where the growing season is long, good results are obtained with this variety.

Aside from the varieties here discussed, a few others, such as Planter's Friend and Collier's, have been grown to a limited extent in various sections of the country. From an agricultural standpoint, however, they are relatively unimportant, and as yet sufficient information is not available concerning their adaption to California conditions to warrant their discussion here.

In order to secure more information as to the relative value of some of the more common varieties, for forage and silage purposes, tests were begun at the University Farm at Davis in 1914. The soil upon which this test was conducted is technically classed as Davis

silt loam. The crop was grown without irrigation in all cases and on land which had produced a crop of corn or grain the previous season. For the purpose of this test, the crop was drilled in rows $3\frac{1}{2}$ feet apart, using about $3\frac{1}{2}$ pounds of seed per acre. Each variety was cut as soon as the seed was ripe, and before the leaves started to wither, or at the stage at which it would ordinarily be harvested for silage. The yields obtained during the seasons 1914 to 1916 are given in table I.

Fig. 2.—Orange sorghum under irrigation at the University Farm. Under good conditions excellent results may be obtained with this variety. It is coarser stemmed and less leafy than the Honey.

TABLE I

VARIETY TRIALS WITH SWEET SORGHUM, DAVIS

(Yield per acre, tons)

Variety	1914	1915	1916	Average
Early Amber	8.13	18.22	10.88	12.41
Red Amber	12.61	25.84	17.75	18.73
Honey	26.09	30.14	26.06	27.43
Orange	15.53	26.70	12.08	18.11
Sumac	19.40	17.26	13.87	16.84

In these trials the Honey sorghum has given strikingly better results than any of the other varieties. It should also be noted that the variation in yield from season to season is less with this variety than with any of the others. Of the first three varieties in the test, the yield is in proportion to the length of the growing season. The Early Amber, which gave the lowest yield, is an early-maturing variety, reaching maturity at Davis in 118 to 130 days. Red Amber matures about two weeks later and Honey about three to four weeks later. The Orange sorghum, on the other hand, is slightly later maturing than the Honey, yet gave a considerably lower yield. The variation in yield for the different seasons is also much greater in the case of the Orange than with the other varieties. The relatively lower yield of the Sumac, which is a very late-maturing variety, is doubtless due to the fact that in none of the three seasons did it reach maturity before the fall frosts occurred. Goose-neck sorghum, previously discussed, was grown in 1915, but the crop was destroyed by frost before it had started to head. The use of this variety as well as that of the Sumac, will doubtless have to be confined to the San Joaquin and Imperial valleys, where the growing season is of sufficient length to permit of their maturing.

In 1917 field tests with three varieties for silage purposes under irrigation were made at the University Farm at Davis, and the results as reported by Professor Thomas Tavernetti are as follows:

	Tons per acre
Red Amber	22.6
Honey	31.4
Orange	25.6

It will be noted that while the actual yields were higher as would be expected, the relative yields are practically the same as when grown without irrigation. In this case, however, the Honey and Orange varieties were allowed to stand in the field for a couple of weeks after maturity and were subject to severe north wind, which whipped off a large proportion of the leaves, thus lowering the actual yield materially.

A variety test was also conducted at the Kearney Park Station in 1917, including practically all of the varieties previously cited. This test was conducted on sub-irrigated land and the results as reported by Mr. J. A. Denny, in charge of the Kearney Park Station, are given in table II.

TABLE II
 VARIETY TRIALS WITH SWEET SORGHUM, KEARNEY PARK, 1917
 (Yield per acre, tons)

Variety	First cutting	Second cutting	Total
Early Amber	12.98	6.57	19.55
Red Amber	31.35	13.83	45.18
Honey	37.52	13.44	50.96
Orange	27.12		27.12
Sumac	48.31		48.31

The fact that three of the varieties made a considerable second growth is of interest. The first crop of Early Amber, Red Amber, and Honey matured the latter part of August and the first week in September. The second cutting was made on November 20; in no case, however, had the second crop reached maturity, though the plants were well headed out. Since frost may occur in that section at an earlier date, the second growth cannot be relied upon. The Orange and Sumac varieties made a little second growth, but not enough to be of any value.

Comparing the results on the basis of the first crop alone, it will be noted that the Sumac gave much the highest yield, with Honey second. The Red Amber, in spite of the fact that it matured somewhat earlier than the Orange, gave a higher yield. On the whole, with the exception of the Sumac, the results are in the same relative order as at Davis.

Goose-neck sorghum was not included in this test, but judging from results obtained throughout the valley it would have stood high in the test in point of yield.

In this connection attention should be called to the fact that the choice of a variety to be grown can not be made on the basis of gross yield alone. Especially is this true when it is to be used for silage and grown as a second crop following grain, grain hay or some other spring crop. In such cases earliness of maturity must also be considered since sorghum, to make good silage, must be fully matured when harvested. As a second crop, therefore, Early Amber and Red Amber will doubtless find the widest use, while in sections with relatively long growing seasons Honey sorghum could be used. The number of days of growth required for maturity by each variety is of interest and is given in table III. The data from the Davis station are averages of three years, while the data from the Kearney Park station are for the 1917 crop only.

TABLE III
PERIOD OF GROWTH OF SWEET SORGHUM
(*Number of days' growth*)

Variety	Davis	Kearney Park
Early Amber	124	124
Red Amber	139	131
Honey	153	138
Orange	160	149
Sumac	180*	155

* Killed by frost, not mature.

Attention is called to the fact that in nearly all cases the period of growth was shorter at Kearney Park than at Davis. This difference is due primarily to a difference in the average daily temperature during the growing season. At Davis the nights are rather cool, resulting in a somewhat lower average temperature than that of Kearney Park. It should also be noted that the differences for the late-maturing varieties are much greater than those for the early-maturing varieties.

These data are especially significant in choosing a variety to grow as a second crop. In the valley it is usually safe to assume that growth will continue until about the 1st to the 10th of November. With the crop planted by the 15th to the 20th of June, it can readily be seen that in the northern section with its relatively cooler nights, only the earlier maturing varieties could be used, while in the warmer section the Honey, and in some cases the Orange variety could be relied upon to reach maturity with a fair degree of certainty.

The data also show that only in the most favorable sections can the late-maturing varieties, such as Sumac and Goose-neck, be relied upon to reach maturity, even where planted at the earliest possible date.

CULTURE

The cultural treatment necessary for the successful production of the sweet sorghums is essentially the same as those for the production of the grain sorghums² and sudan grass³ which are discussed in previous publications. Where they are to be grown as a dry-farm crop, special emphasis must be placed on the storage and conservation of moisture, the preparation of the seed bed, and the care of the crop during the growing season. This is especially important since the

² Univ. Calif. Agr. Exp. Sta. Bul. 278.
³ Univ. Calif. Agr. Exp. Sta. Bul. 277.

crop is grown during the dry season of the year, and though it is quite tolerant of drouth, the results obtained will usually be in proportion to the supply of moisture and the condition of the soil.

Preparation of the Seed Bed.—For the best results the land should be plowed rather deeply in the fall or early winter before the heavy rains begin, and allowed to remain rough until spring. In this condition the soil will absorb a large proportion of the rainfall and will also be materially benefitted by the weathering action. As soon as most of the rains are over, the surface of the soil should be worked down to a good mulch with a disc and harrow and maintained in that condition until planting time. When spring plowing is necessary it should be somewhat more shallow than fall plowing, otherwise too much work will be required to prepare the land properly. It is, in fact, nearly always more difficult to prepare a good seed bed on spring than on fall-plowed land. Where sorghum is to be grown as a second crop, following grain or grain hay, the usual procedure is to irrigate the land, plow rather shallow, and then work down immediately to a seed-bed condition.

The seed bed should be smooth and even, with a mulch of two to three inches on the surface. The soil below the mulch should be firm and moist. If the soil is too loose for a good seed bed, rolling may be necessary before planting the crop to pack the soil and bring the moisture nearer to the surface. The best implement for this purpose is a corrugated or Dunham roller.

Time of Seeding.—As a rule, sorghums should be planted somewhat later than Indian corn. Planting should not be done until the soil has warmed up sufficiently for prompt germination. If the soil is too cold, the seed will germinate slowly, and the subsequent growth is apt to be stunted. In the Sacramento and coast valleys, the best time to plant is about the middle of April. In the San Joaquin and Imperial valleys, planting may be done about April 1. On the other hand, if planting is delayed until the first to the middle of May, the soil is apt to become too dry to germinate the seed, unless irrigation can be provided. On irrigated land, planting may be delayed as late as the middle to the latter part of June. This fact is made use of by employing the sorghum as a second crop. In such cases, however, an early-maturing variety should be used.

Method and Rate of Seeding.—The method of seeding sorghums will be determined largely by the purpose for which they are grown. When the crop is to be used for fodder or silage, it is usually planted in rows 3 to 3½ feet apart, using about 2½ to 4 pounds of seed per

acre. The exact rate of seeding must be governed by the character of the soil and the supply of moisture. On strong soil well supplied with moisture, the heavier rate of seeding may be used, while on soils of doubtful fertility and only moderately well supplied with moisture, lighter seeding should be practiced.

The implement commonly used for planting the crop is the corn planter, fitted with sorghum-seed plates. The grain drill is also sometimes used by stopping up enough of the holes to give the proper spacing. This implement, however, often plants too shallow and uses more seed than necessary for the best results.

The depth to which the seed should be planted will vary with the character of the soil and the condition of the seed bed. It is important, however, to plant the seed deeply enough so that it is placed in contact with moist soil where it may quickly absorb the moisture necessary for germination; ordinarily two to three inches in depth is sufficient.

When sorghum is to be grown for hay or pasture, it is usually seeded broadcast or in close drills like grain. For this purpose the grain drill is the most efficient implement to use as it places all the seeds in the soil at a uniform depth. Broadcasting is not as good, since much of the seed will not be covered deeply enough to get into moist soil and hence will not germinate. The usual rate of seeding sorghum in close drills is from 30 to 40 pounds per acre. When seeded broadcast, more seed must be used per acre in order to get a good stand.

Care of the Crop.—The cultivation which the crop will require after planting will depend to a large extent on the condition of the field and the season. The sorghums grow rather slowly at first and if the field becomes weedy, while the plants are yet quite small, the weeds may be destroyed with a harrow without severe injury to the crop. On the other hand, if the surface of the soil becomes crusted while the plants are small or before the seedlings appear, this crust must be broken, otherwise injury to the young plants is apt to result. If the crust is not too thick it may be broken with a light harrow, but a better implement to use is a corrugated or Dunham roller, which pulverizes the surface without tearing out the plants. When the crop has been planted in rows, 3 to 3½ feet apart, it should be cultivated as soon as the plants are large enough so that the row can be seen plainly. Two to three similar cultivations should be given at intervals of two to three weeks, or until the plants attain a height of about three feet, after which no further cultivation will be neces-

sary. When the crop is irrigated it is well to cultivate after each irrigation in order to reestablish the mulch and prevent evaporation.

The first cultivation of the season should be rather deep in order to form a good deep mulch and force deep rooting. Later cultivation, however, should be more shallow.

Where sorghums are grown in close drills for hay or for pasture, no cultivation is possible other than the initial harrowing while the plants are small.

Irrigation.—While the sorghums are preëminently dry-land crops, the application of water, whenever possible, will in nearly all cases be amply justified by the increased yields. The use of the sorghums as a second crop following grain or grain hay, will be possible only under irrigation. In such cases the land must be irrigated before planting in order to insure sufficient moisture to germinate the seed.

The time of irrigation and the number of irrigations will depend wholly upon local conditions. The best time to irrigate the growing crop is when the plants start to head. From this time on the plants are making their most rapid growth and hence are drawing heavily upon the moisture supply. When the land has been well watered before planting, the crop can usually be matured without further irrigation. In many instances, however, one additional irrigation may prove beneficial. Late irrigation particularly should be avoided as it greatly stimulates the growth of suckers, causing the product to mature unevenly. There is also a tendency to increase lodging and to stimulate a second growth prematurely if water is applied too late.

Sorghums may be irrigated either through furrows or by flooding. Where the condition of the field will permit, the latter method is to be preferred, because of the smaller amount of labor involved.

HARVESTING

Sorghums which are being grown for silage should not be cut until the seed is in the hard dough stage. If cut earlier the silage is apt to be sour and of poor quality. To avoid this possibility it is even better to allow the seed to become fully mature before cutting. It is, of course, true that as the plants reach maturity the fiber increases rapidly, but this is less objectionable in silage than in other forms of forage. The usual method of harvesting is with a corn binder.

For fodder purposes sorghum may be cut at any time after the heads are formed. Probably the best stage of growth is just as the

seed is forming or while it is in the milk. In this stage the crop has practically attained its maximum growth, while the plants are less fibrous and hence of higher feeding value than if allowed to become more nearly mature.

The fodder crop, like the silage crop, is usually cut with a corn binder. Where the climate is dry the bundles may at once be set in shocks to cure, after which they may either be fed directly from the field or put into a stack. In the more humid sections more care is necessary to prevent the fodder from molding. Ordinarily the bundles should be allowed to dry for a few days on the ground after which they are set up into small shocks to complete the curing process.

When seeded broadcast or in close drills for hay, the best time to harvest compatible both with maximum yields and feed value, is when the plants start to head. By harvesting at this stage of growth, two and sometimes three cuttings per season may be obtained. Furthermore, if cut at this stage the stems are soft and succulent and if properly cured will be readily eaten by livestock.

The hay crop is commonly cut with a mower and allowed to cure in the swath for a day or two, after which it is raked into windrows and then put into cocks to complete the curing process. This is the most rapid method of getting rid of the moisture, but often results in a harsh hay. The method preferred by many is to allow the hay simply to wilt in the swath and then to put it into small size cocks to cure. By this process the hay cures more slowly, but retains its color and is believed to result in a more palatable feed.

In a few instances, the grain binder has been used for harvesting the hay crop, the bundles being set up into small shocks to cure. With a heavy crop, however, some difficulty will be experienced in getting the binder to handle it. The chief advantage for this method is that it is easier to handle the fodder in bundles than when it is loose.

Danger from Poisoning.—When sorghums are pastured or fed green apprehension is sometimes felt regarding the danger to stock from poisoning. Under certain conditions when the plants are stunted in their growth, prussic (hydrocyanic) acid, which is quickly fatal to stock, develops in the leaves. With the plants in a normal, thrifty state of growth, this danger is practically nil. In fact, the proportion of losses from sorghum poisoning as compared with losses from other preventable causes is very small. When the plants are cured the poison disappears from the leaves, so that there is no danger from feeding the cured forage, nor have any losses been reported from feeding sorghum silage.

SORGHUM IN THE ROTATION

Sorghums may be employed in the rotation like Indian corn or any other spring crop. While they are reported to be hard on the land, there is no evidence to show that they take from the soil any more plant food in proportion to their growth than other crops. Because of the fact that the sorghum roots are bunched near the surface of the ground, they do leave the soil in poor physical condition, which probably accounts for the observed injurious effect on the succeeding crop. If, however, the land is plowed as soon as the crop is removed, and allowed to aerate for a month or more before seeding, any injurious effect of the sorghum on the soil will practically disappear.

Sorghum, however, should not be grown on the same land many years in succession. Continuous cropping to sorghum will soon result in a poor yield. This is indicated to some extent in a test at Davis, started in 1914, the data on which are given in table IV.

TABLE IV
EFFECT OF ROTATION ON SORGHUM

Year	Sorghum continuous	Sorghum after corn
1914	7.00	8.13
1915	12.63	18.22
1916	7.73	17.75
1917	8.22	

On the continuously cropped series, Early Amber was used in 1914 and 1915, and Red Amber in 1916 and 1917. During the last two years, however, the plants in the series were weak and sickly looking, even early in the season, while the growth on the whole was inferior to that of the crop following corn.

Some growers have had difficulty of disposing of the stubble and roots after the crop has been harvested. If, however, a fourteen or sixteen inch mouldboard plow or a large disc plow is used, and the field plowed soon after the crop is harvested, the stubble can be turned under quite readily. The large crowns will ordinarily be sufficiently disintegrated by the winter rains to cause but little trouble.

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138. The Silo in California Agriculture.	177. Grain Sorghums.
139. The Generation of Hydrocyanic Acid Gas in Fumigation by Portable Machines.	181. Control of the California Ground Squirrel.
140. The Practical Application of Improved Methods of Fermentation in California Wineries during 1913 and 1914.	182. Extending the Area of Irrigated Wheat in California for 1918.
142. Practical and Inexpensive Poultry Appliances.	183. Infectious Abortion in Cows.
143. Control of Grasshoppers in Imperial Valley.	184. A Flock of Sheep on the Farm.
144. Oidium or Powdery Mildew of the Vine.	185. Beekeeping for the Fruit-Grower and Small Rancher, or Amateur.
147. Tomato Growing in California.	186. Poultry on the Farm.
148. "Lungworms."	187. Utilizing the Sorghums.
150. Round Worms in Poultry.	188. Lambing Sheds.
151. Feeding and Management of Hogs.	190. Agriculture Clubs in California.
152. Some Observations on the Bulk Handling of Grain in California.	191. Pruning the Seedless Grapes.
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