turf areas subjected to heavy use. Vertical mulching has been proposed as a means of overcoming this problem.

The results of this study indicate that closely spaced vertical mulch holes will increase infiltration rates. This increase is linearly related to the closeness of spacing of the holes. In these tests, the infiltration rates on all plots decreased as the season progressed. This decrease is a characteristic of most soils in California. In late September, the rates were less than ½ inch per hour for the 3-inch spaced holes; and less than ⅕ inch per hour for the widely spaced holes, mechanically aerified plots, and nontreated areas. Infiltration rates were found to be quite variable even within a small area. This points out the desirability of having a large number of replicated infiltration measurements in studies of this type.

Vigorous growth

Vertical mulching or mechanical aerifying did not increase the percentage of bentgrass over *Poa annua* as indicated by visual observation. Vertical mulch holes and mechanically aerified holes, backfilled with sand and organic matter, provided an excellent environment for vigorous growth of grass roots.

The soil on which these tests were conducted was a 12-inch layer of clay loam and sand mix overlying a crushed rock base. The vertical mulch holes did not penetrate the full depth of the soil material. Different results might be expected where the vertical mulch holes penetrate through a dense or stratified surface layer into a more pervious soil beneath.

Good growth of any plant is related to several interdependent factors. Although close-spaced vertical mulching does significantly increase water infiltration, this practice by itself does not appear to be the complete solution to the problem of improving old greens. Further information on the interrelationship between vertical mulching and other cultural practices is needed.

It is quite possible that a better irrigation system coupled with vertical mulching would take better advantage of the improved root environment provided by vertical mulch holes filled with an improved soil mix. Further studies are in progress.

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Pasture and greenchop performance comparisons . . .

PIPER SUDANGRASS AND SUDAN HYBRIDS UNDER IRRIGATION

D. C. SUMNER · V. L. MARBLE · E. J. GREGORY

Many trials comparing the yielding ability of some of the sudan hybrids with Piper sudangrass have failed to show any significant differences in pasture production when based upon dry matter produced. Greenchop operators in California utilize these summer annuals in every stage of growth from near 20 inches in height to near maturity. The height at which these crops are harvested as greenchop depends upon how often the stand must be recut to keep material moving to the feeding operations. The data presented here suggests that if greenchop operators harvest their crop at about 5 to 6 ft or less in height, there is little or no advantage in using hybrids. If, however, greenchopping is confined to plant material, 7, 8, or 9 ft in height, there is a definite yield advantage from using the excellent sudan hybrids.

AGRICULTURE IS BEING offered a number of hybrid varieties of sudangrass for use as annual summer pasture and greenchop. These hybrids originate from crosses between two sudangrass varieties, sudangrass and grain sorghums, forage sorghums, or sorgos. These cultivars produce well and provide feed of good quality. The sorghum-sudan hybrids generally retain some characteristics of both parents; most being thick stemmed, late maturing, and tall.

For the past three years Piper sudangrass and cultivars representing some of the hybrid types were tested in comparative yield trials under irrigation at Davis. Piper sudangrass was used as the standard in these trials—not because it is more productive than other sudangrass, but it is popular and widely used in California.

In 1961, Piper sudangrass, SX-11 (grain sorghum × sudangrass), and NK-300 (a hybrid forage sorghum normally used for silage) were tested for pasture and greenchop yield. Pasture conditions were simulated by harvesting these cultivars when each reached 2 ft in height. Greenchop conditions were simulated by harvesting each variety at the 50% late-boot stage (when 50% of booted tillers have heads already emerged or starting to emerge; could also be designated as very early heading).

Pasture trials showed a higher percentage of moisture and protein for SX-11 and NK-300 at the same height as Piper sudan, while at the greenchop stage of development—when the cultivars were near the same stage of maturity—there was less difference in protein values. However, the hybrids still contained a greater percentage of moisture. When used as pasture, there was no significant difference in dry matter yield between a sudangrass, a sorghum-sudan hybrid, and a hybrid forage sorghum. Under greenchop conditions, the hybrid forage sorghum was significantly lower yielding than the other two. This can be attributed to a slower recovery rate after harvest, slower growth prior to the last cutting

TABLE 1. COMPARISON OF PASTURE AND GREENCHOP DRY MATTER AND GREEN WEIGHT YIELDS OF SUDANGRASS, A SORGHUM-SUDANGRASS HYBRID, AND A SUDAN HYBRID—1962

	Season D.M.	Total green weight	% Ave. moisture	Ave. plant height (in.)
PASTURE Harvested when Piper sudan reached near 30 inches in height (Average of 10 replications)				
Piper	9.63	63.67	84.82	30.2
SX-11	9.55	70.61	86.42	27.8
Suhi-1	9.15	66.79	86.26	26.6
LSD (.05)	NS	3.14		
(.01)	NS	4.31		
GREENCHOP Harvested when Piper reached 50% late boot				
Piper	58.36	79.34	12.06	54.7
SX-11	77.46	85.06	11.58	50.3
Suhi-1	69.31	84.49	10.75	47.6
LSD (.05)	4.45		0.49	
(.01)	6.13		0.67	

TABLE 2. COMPARATIVE PASTURE YIELDS OF FIVE CULTIVARS BASED ON GROWTH OF PIPER SUDANGRASS AND SX-11 SEEDED MAY 18, 1963

Cultivars	Cutting dates: June 20	July 8	July 22	Aug. 8	Aug. 28	Sept. 16	Oct. 21	Season total	Ave. protein	Crude protein	Ave. fiber	Ave. canopy height
Piper Sudangrass*				T/A				T/A	%	T/A	%	in
Piper	0.24	1.00	1.09	1.25	1.38	1.10	1.39	7.46	17.0	1.30	26.1	25.8
Trudan-1	0.35	1.01	0.97	1.18	1.25	0.94	1.46	7.18	17.9	1.30	26.1	27.1
SX-11	0.33	0.97	0.94	1.18	1.26	1.01	1.43	7.14	18.0	1.30	25.3	24.3
Grazer	0.42	0.94	1.06	1.19	1.28	0.93	1.43	7.25	17.7	1.30	25.5	23.8
Sweet Sioux	0.42	1.02	1.00	1.21	1.25	0.95	1.41	7.27	17.3	1.30	26.2	24.3
LSD (.05)	NS	NS	0.10	NS	NS	0.09	NS	NS			0.5	0.7
LSD (.01)	NS	NS	NS	NS	NS	0.12	NS	NS			NS	1.0
SX-11†	June 20	July 12	July 31	Aug. 19	Sept. 10	Oct. 4						
Piper	0.55	1.57	1.47	1.40	1.45	1.02		7.46	17.2	1.30	26.7	29.9
Trudan-1	0.66	1.39	1.33	1.29	1.37	0.88		6.91	17.0	1.20	27.2	29.9
SX-11	0.70	1.50	1.35	1.29	1.35	1.04		7.24	18.9	1.40	25.5	26.4
Grazer	0.83	1.41	1.36	1.33	1.44	0.91		7.30	17.9	1.30	25.9	26.0
Sweet Sioux	0.75	1.38	1.35	1.31	1.38	1.03		7.20	18.2	1.30	26.7	27.1
LSD (.05)	0.15	0.12	NS	NS	NS	NS		0.34			0.4	0.6
(.01)	0.20	NS	NS	NS	NS	NS		NS			0.6	0.9

* Six replications, based on growth of Piper Sudangrass.
† Nine replications, based on growth of SX-11.

in October, and a thinning stand after each cutting. These characteristics have also been observed in sorghum-sudan hybrids. When the same cultivars were again compared as greenchop in 1962, the seasonal dry matter production for Piper sudan was 11.89 tons per acre; SX-11, 11.70 tons per acre, and NK-300, 10.11 tons per acre (differences were not statistically significant).

Piper sudan, SX-11, and Suhi-1 (Rhodesian sudangrass × Tift sudan) were also tested in 1962 as pasture and greenchop. All three cultivars were harvested in the pasture stage when Piper reached near 30 inches in height and for greenchop, when Piper reached the 50% late-boot stage. Treatments were replicated 10 times at each harvest period. Comparisons of pasture yields on a green weight basis showed both SX-11 and Suhi-1 outyielded Piper, with a significant difference for SX-11 (see table 1). However, calculation based on seasonal yields of the amount of dry matter produced, showed no significant difference between cultivars. When greenchop yields are calculated on green weight, both SX-11 and Suhi-1 significantly outyield Piper sudan. Removing the water and calculating dry matter yields showed no significant difference between Piper and SX-11—and both significantly outyielded Suhi-1.

The Agricultural Extension Service conducted a similar trial in Fresno County in 1963 using Piper sudan, SX-11, Trudan-1 (hybrid sudangrass), and Sweet Sioux (sorgo × sudangrass) with essentially the same results. The trials were harvested at two stages of maturity: pasture stage, when Piper sudan reached 2 to 3 ft in height (resulting in five harvests); and greenchop stage, when Piper sudan reached 50% late boot (resulting in three harvests per season). When yields were determined on a green or fresh weight basis, the hybrids again outyielded Piper sudangrass. When converted to dry matter, however, there was no significant difference in yield. There was little difference in total seasonal yield of TDN per acre between cultivars.

Yield trials conducted thus far show that green weights favor the hybrids; but when total dry matter per acre is compared, there is little or no difference between sudangrass and hybrids for pasture or early greenchop.

During the 1963 season, yield of Piper sudangrass, Trudan-1, SX-11, Grazer (forage sorghum × sudangrass), and Sweet Sioux were tested. Two sets of five, replicated, trials were established. Each of the five trials contained all five cultivars, and the harvest of each trial was based upon the stage of development of one of the five cultivars. This arrangement provided for yield comparisons between all five cultivars when each of the cultivars reached near 2 ft in height and again when each cultivar of the second set of trials reached 50% late-boot stage.

TABLE 3. COMPARISON OF YIELDS BETWEEN CULTIVARS WHEN EACH SERIES IS HARVESTED WHEN ONE IN EACH SERIES REACHED 50% LATE BOOT

Total seasonal yield in tons of dry matter/acre.
Davis, 1963. Average of 3 replications.

Cultivars	Harvested when the following reached 50% late boot: Piper	Trudan-1	SX-11	Grazer	Sweet Sioux	Total† season yield for each cultivar: D.M. T/A	Crude protein T/A
Piper	9.69*	10.03	11.59	10.40	9.43	11.26	1.48
Trudan-1	10.61	10.93*	13.24	11.79	12.08	11.34	1.41
SX-11	9.58	9.80	12.73	12.08	11.53	12.73	1.18
Grazer	9.52	10.11	12.81	11.80	13.03	11.80	1.08
Sweet Sioux	9.72	11.03	12.96	12.67	12.20	12.20	1.13
LSD (.05)	NS	NS	NS	NS	NS		

* Regrowth harvest of 1.57 tons D.M. from Piper and 1.41 tons from Trudan-1 at last cutting date (21 Oct.) of SX-11, Grazer, and Sweet Sioux not included.
† The above additional yields added to Piper and Trudan-1.

TABLE 4. COMPARATIVE DATA WHEN CULTIVARS ARE HARVESTED AT 50% LATE BOOT

Cultivar	Crude protein	Fiber	D.M.	Height	Date harvested	Days to harvest	D.M.
	%	%	%	in			T A
1st Harvest							
Piper	13.4	29.8	19.1	54	July 5	48	2.43
Trudan-1	12.4	28.7	15.1	66	July 8	51	2.95
SX-11	10.1	32.5	15.6	75	July 15	58	4.78
Grazer	8.4	32.4	17.6	80	July 17	60	4.66
Sweet Sioux	7.0	36.0	20.0	96	July 22	65	5.81
2nd Harvest							
Piper	11.3	34.0	20.0	69	Aug. 12	38	4.02
Trudan-1	9.0	35.5	18.6	76	Aug. 16	39	4.52
SX-11	7.0	34.2	19.9	88	Sept. 9	56	6.20
Grazer	9.1	34.2	18.2	90	Sept. 14	59	5.81
Sweet Sioux	9.9	34.9	19.9	108	Sept. 20	60	5.63
3rd Harvest							
Piper	12.3	32.8	21.0	69	Sept. 27	46	3.24
Trudan-1	10.3	36.2	19.8	89	Oct. 4	49	3.46
SX-11*	15.9	26.3	15.3	41	Oct. 21	42	1.75
Grazer*	20.4	24.4	13.7	32	Oct. 21	37	1.33
Sweet Sioux*	24.0	23.7	14.8	22	Oct. 21	31	0.76
4th Harvest							
Regrowth of Piper and Trudan-1. Harvested October 21							
Piper*	20.3	26.8	16.7	29	Oct. 21	24	1.57
Trudan-1*	20.4	26.7	16.9	30	Oct. 21	17	1.41

* Vegetative growth only.

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This plot design eliminated irrigation and harvesting difficulties. It soon became apparent that in the pasture trials, the recovery and growth rate of Piper and Trudan-1 were so nearly identical that these two sets of plots were combined into one harvest schedule based upon Piper sudan. The recovery and growth rates of SX-11, Grazer, and Sweet Sioux were also so nearly equal that these plots were combined and harvested along with SX-11. Table 2 lists comparative pasture yields of all five cultivars at each harvest date and the total seasonal yield for both harvest schedules.

Temperatures after October 4 were low enough to reduce the growth rate so that there was insufficient material on the SX-11 harvest scheduled plots to warrant harvesting when the trials ended on October 21. The dry matter production per acre per cultivar for the season was not influenced by the harvesting schedule. At nearly all harvest dates, the dry matter percentage for Piper was one to two points higher than the other cultivars. Piper and Trudan-1 are earlier maturing than the other three cultivars, and the differences in fiber content demonstrate a later morphological stage of maturity.

Recordings of stages or degrees of maturity taken from the first harvest date of each cultivar show a rather wide range of maturity between cultivars. Because of the differences in the degree of maturity at any one harvest, height or date of harvest, corresponding differences in dry matter, protein, and fiber percentage can be expected between cultivars. The plant heights of all the cultivars harvested when Piper and Trudan-1 reached 50% late boot were very nearly equal: about or near 6 ft tall, varying between harvest dates. However, when the later maturing cultivars reached 50% late boot, the leaf canopy height ranged between 7 and 9 ft tall.

Table 3 records the seasonal yield in dry matter per acre for each of the five cultivars at each of the five harvest schedules. Though not significant, the hybrids outyielded Piper sudan when the harvests were based upon the later maturing and taller hybrids. The data collected from these yield trials, as presented in table 4, illustrates the difference in yielding ability, dry matter percentage, plant height, protein and fiber percentage, and number of days to harvest. Plant height was measured from ground surface to the top canopy of leaves. The results show that when these cultivars are harvested at the same late morphological stage of maturity, the sorghum-sudangrass hybrids outyield Piper and Trudan-1. It is evident, however, that the superior yielding ability of these hybrids results from later maturity and increased height at the later stages.

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