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## Forage from Kochia (KOCHIA SCOPARIA L.)

E. L. Erickson

A. L. Moxon

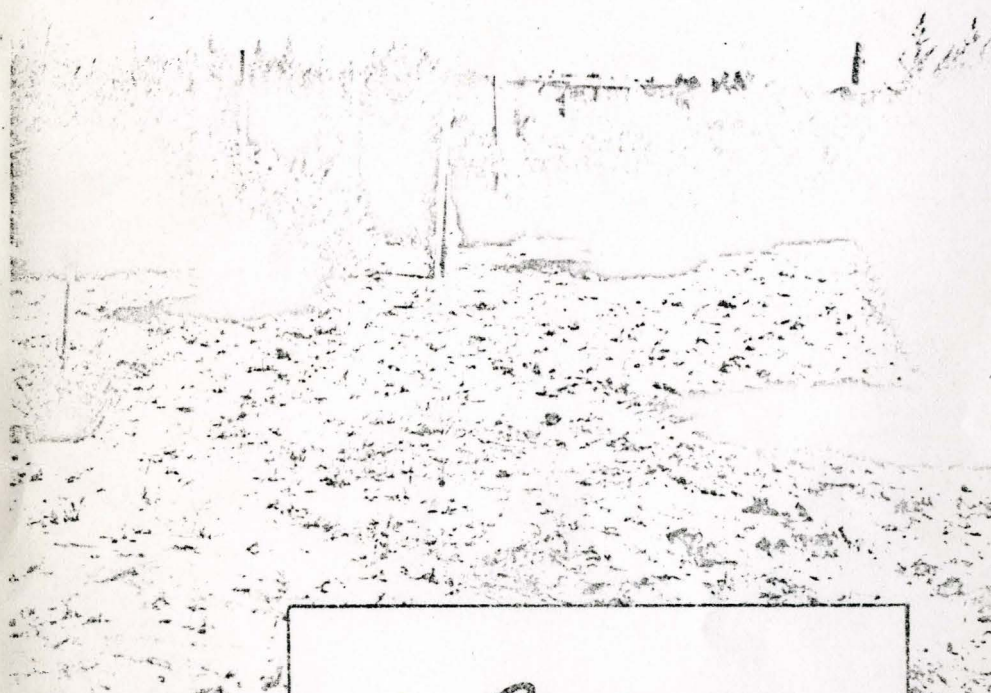
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*Forage*  
FROM  
*Kochia*

KOCHIA SCOPARIA L.

Part 1. Some Plant Characteristics and Forage Production.

Part 2. Apparent Digestibility, Palatability and Other Feeding Qualities Compared with Alfalfa Hay.

AGRONOMY  
DEPARTMENT

CHEM  
DEPAR

*Agricultural* EXPERIMENT STAT

### Management and Cultural Recommendations

Kochia (fireweed) is an annual and a member of the goosefoot family. It can be controlled readily by the prevention of seed production by cultivation or by close mowing at the pre-bud stage.

Kochia has been commonly known as a large coarse weed, because it is most conspicuous at that stage in the fall. Research on this species reported in this bulletin shows that the early growth is leafy, palatable and nutritious.

In the experimental feeding of fresh Kochia to cattle and Kochia hay to cattle and sheep no difficulty was experienced. There were no apparent ill effects to a dairy cow which consumed daily increasing amounts of fresh Kochia, up to 72 pounds, with grain and alfalfa hay.

Outstanding characteristics of Kochia are drouth resistance, grasshopper resistance, leafiness, high seed yields, high protein and carbohydrate content and yielding ability for hay or silage. It is highly palatable.

Seed of the wild strain of Kochia collected in South Dakota was used in the preliminary experiments. Wild seed can also be used by others for small trials. Large acreages probably should not be planted for forage until more is known about cultural methods and improved strains.

It requires about one-half to one day longer to field cure Kochia hay than it does for alfalfa hay. Kochia plants are hairy which gives the cured forage a grey color, and this should not be confused with mold or spoilage, which it resembles.

Plant types have been selected from the wild strain. Several years of inbreeding has revealed much variability in the types. It is apparent that improved strains can be developed for forage production.

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# FORAGE from KOCHIA

*Kochia Scoparia L.*

## Part I

### Some Plant Characteristics and Forage Production

By E. L. ERICKSON<sup>1</sup>

#### Introduction

In South Dakota during years of insufficient rainfall forage yields of alfalfa and the established grasses are greatly reduced. In years of drought such as occurred in 1934 to 1936, the forage produced is insufficient to carry the livestock. During such times hay has been made from wild plants or weeds, including Russian thistle. Many specific instances have been related by ranchers and farmers that such "weed hay" was all that enabled them to keep their breeding stock during the drought years.

The fact that Russian thistle had been used as hay and had enabled ranchers and farmers to maintain the nucleus of their breeding herds is extremely significant. The limited qualifications of Russian thistle as a forage is well known.<sup>2</sup> It appeared that some other plant might have more desirable forage characteristics and yet approach the tenacity and drought resistance of Russian thistle. Several closely related plants were observed during 1940 with respect to growth habit, leafiness and seed production. *Kochia scoparia L.* produced an abundance of leafy growth (figures 2-5) and grew well in places apparently lacking in soil moisture. The protein content was high, the sample analyzed in 1940 containing 3.18 percent protein. It also had a satisfactory hay aroma.

Following the preliminary observations and study of *Kochia*, experiments were set up to obtain data on the forage characteristics of the plant and to determine the value and use of *Kochia* as a forage in South Dakota.

The work reported in this bulletin was done during 1940-1946 and involved the study of *Kochia* as a forage plant and its utilization as forage by livestock. Seed of *Kochia scoparia L.* was collected from wild stands. Studies of yield, habit of growth, forage quality and composition were made at the South Dakota Agricultural Experiment Station and at the central sub-station, Highmore, South Dakota.

#### Review of Literature

According to Gray's New Manual of Botany, the genus *Kochia* belongs to the Chenopodiaceae (goosefoot family). The species reported on here is "*Kochia scoparia (L.) Schrad.* Annual, erect, puberulent or glabrate, branching; leaves narrowly lanceolate to linear; flowers in small axillary clusters, sessile; each sepal at length developing a narrow thickish dorsal wing or appendage. Frequently cultivated for its bright autumnal color; locally established as a weed. (Introduced from Europe)."<sup>3</sup>

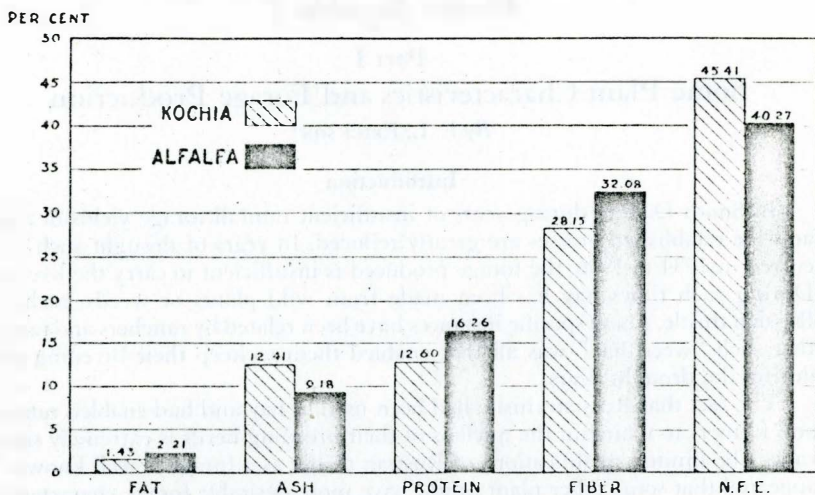
<sup>1</sup>Formerly Assistant Agronomist, South Dakota Agricultural Experiment Station. The author acknowledges with thanks the help and encouragement given by staff members of the departments of Agronomy, Chemistry, Animal Husbandry and Dairy Husbandry.

<sup>2</sup>Cave, Riddell and Hughes, 'The Digestibility and Feeding Value of Russian Thistle Hay,' *Journal of Dairy Science*, April, 1936, Vol. XIX, p. 285.

<sup>3</sup>Gray's New Manual of Botany, 7th Edition by Robinson and Fernald. American Book Company.



## COMPOSITION OF KOCHIA, FIRST CUTTING,<sup>1</sup> AND ALFALFA ALL ANALYSES<sup>2</sup> ON MOISTURE FREE BASIS



<sup>1</sup> 1943-1944, HIGHMORE, S. DAK.

<sup>2</sup> ADAPTED FROM "FEEDS AND FEEDING" - F. B. MORRISON

Regarding its habitat, Muenscher states that it occurs on "waste places, ballast grounds and occasionally in fields, mostly in dry soils."<sup>4</sup>

This species is known by several common names, including Summer cypress, Kochia, Burning bush, Fireball, Mexican fireweed, Fireweed and Belvedere.<sup>5, 6</sup>

A search of the literature reveals that no study has been made of *Kochia scoparia* as a source of forage or of its forage qualities. However, some observations and analyses have been reported on some species of this genus.

Bidwell and Wooton, in reporting their results from an extensive study on chemical analysis of the saltbushes and related plants, analyzed one sample of *Kochia scoparia* which contained 22.6 percent crude protein. As to its occurrence, they state "It appears mainly as a waste ground weed in towns and on roadsides, but seems able to compete for a place on the range."<sup>7</sup>

In the Nebraska Agricultural Experiment Station Circular 67, by Frolick and Frolick, is a photograph showing sheep grazing large and nearly mature Kochia plants, with the caption, "Kochia (fireweed) may afford some pasturage."<sup>8</sup>

Chepil reports that seeds of six species among a total of 58 studied had a life span in cultivated soil not exceeding one year. Of one of the six, *Kochia trichophylla*, he says, "*Kochia trichophylla* is an ornamental plant that has escaped

<sup>4</sup>Muenscher, W. C., "Weeds," P. 213. The Macmillan Company, New York, 1935.

<sup>5</sup>Ibid.

<sup>6</sup>Britton and Brown, "Illustrated Flora of the Northern States and Canada," Vol. II, P. 16.

<sup>7</sup>G. L. Bidwell and E. O. Wooton, "Saltbushes and Their Allies in the United States," U.S.D.A., Bul. No. 1345.

<sup>8</sup>A. L. Frolick and E. F. Frolick, "Nebraska Pastures, Seeding and Management," Nebraska Agricultural Experiment Station Circular 67, P. 16.

cultivation, but apparently due to low degree of dormancy of seeds has never become a very serious weed. The great majority of the seeds germinate very early in the spring and the rest remain dormant for a period not exceeding two or three months.<sup>9</sup>

Martin has reported the dates of germination of seed of many weed species in the field. He found that *Kochia scoparia* seeds germinated earliest in the three years that data were recorded. The dates of field germination for *Kochia scoparia* at Ames, Iowa, were March 1, 1935; February 28, 1936, and April 1, 1941.<sup>10</sup>

The author has observed that *Kochia* seeds germinate very early in the spring, and that the late snow and the thawing and freezing apparently do not injure the *Kochia* seedlings. This indicates that the seeds are capable of germinating at low temperatures and that the seedlings are extremely resistant to injury from freezing.

The foregoing facts are important in understanding the species and in developing management practices. Since the great majority of *Kochia*\* seeds germinate before May 15 and have a short period of dormancy in field soil, the plants can readily be controlled by pre-cultivation. Where it is desirable to grow *Kochia*, the seed may be fall sown and will obtain a very early start when conditions of moisture are most favorable for growth.

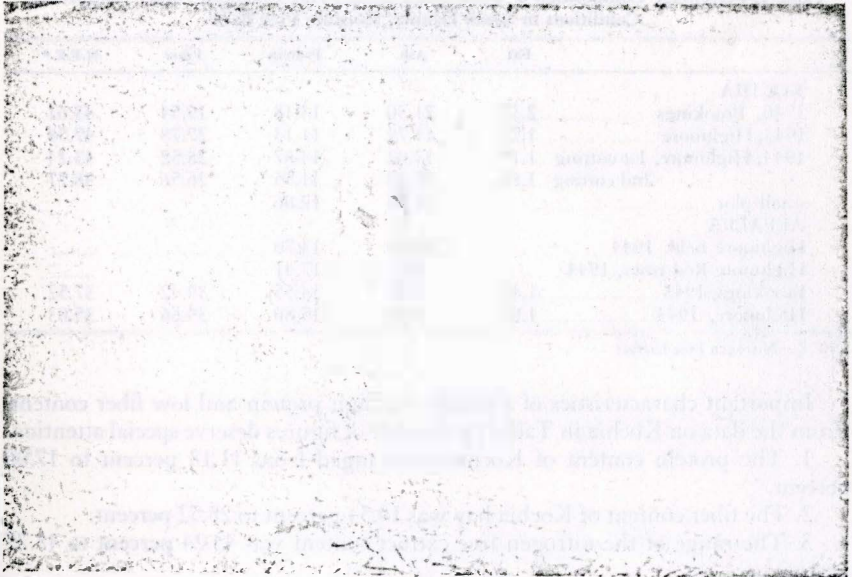


Fig. 2. A plot of *Kochia* at Brookings, 1945, five weeks after planting, showing plants six inches high and the leafy character of growth.

<sup>9</sup>"Germination of Weed Seeds," W. S. Chepil *Scientific Agriculture* 26:7; July, 1946.

<sup>10</sup>"Germination Studies of the Seeds of Some Common Weeds," Martin, John N., *Iowa Academy of Science*, Vol. 50.

\**Kochia* will hereinafter be used to mean *Kochia Scoparia* L.

### Materials and Methods of Research

Kochia plants were collected from several locations in the state for protein analysis. Seed was likewise collected from wild stands for selection purposes and for forage and seed yield studies. Kochia was compared with other known annual forage plants, Siberian millet, Hubam and Golden annual sweet clover. For forage and seed yields Kochia was seeded at 12 to 15 pounds per acre in plots five by fifteen feet in restricted randomized plots replicated five times. The millet crop was harvested when fully headed but still in green and growing condition. For hay Kochia was cut when 18 to 26 inches high, (Fig. 3). In obtaining data on seed yield seven plots one yard square were used.

The field seedings were mowed, windrowed on the next day, and the hay was stacked when field curing was judged to be complete. Moisture samples of five pounds were air dried and the hay yields are reported on air dry basis. The stacked hay was baled and stored for use in feeding tests.

### Results

**Composition of Kochia Hay Compared with Alfalfa Hay.** The composition of Kochia and alfalfa from different locations in the state has been determined during the several years. Soil type, stage of growth, curing and other factors may influence the composition of hay. The figures in Table 1 provide a range in composition for South Dakota alfalfa and Kochia.

Table 1. Percentage Composition of Kochia and Alfalfa Hay Produced Under Comparable Conditions in South Dakota, Moisture Free Basis

	Fat	Ash	Protein	Fiber	N.F.E.*
<b>KOCHIA</b>					
1940, Brookings .....	2.37	21.30	13.18	19.54	43.61
1943, Highmore .....	1.72	11.79	11.13	27.78	47.58
1944, Highmore, 1st cutting ..	1.15	13.02	14.07	28.52	43.24
2nd cutting ..	1.81	12.03	11.55	26.56	48.77
small plot .....		14.25	17.06		
<b>ALFALFA</b>					
Highmore field, 1944 .....		10.60	13.70		
Highmore Rod rows, 1944 .....		8.61	17.41		
Brookings, 1943 .....	1.49	7.02	14.55	39.42	37.52
Highmore, 1944 .....	1.02	8.49	15.80	39.66	35.03

\*N.F.E.—Nitrogen Free Extract

Important characteristics of a forage are high protein and low fiber content. From the data on Kochia in Table 1 a number of figures deserve special attention.

1. The protein content of Kochia hay ranged from 11.13 percent to 17.06 percent.
2. The fiber content of Kochia hay was 19.54 percent to 28.52 percent.
3. The range of the nitrogen free extract content was 43.24 percent to 48.77 percent.
4. The ash content of Kochia ranged from 11.79 percent to 21.3 percent. The content of protein, fiber, and nitrogen free extract are satisfactory for good forage. It is not known whether the ash content is too great.

**Composition of Kochia plants from Different Locations.** In 1942 samples of Kochia hay were collected from several locations in the state (Fig. 6) and analyzed. The data are shown in Table 2.



Table 2. Composition of Kochia hay from several locations in South Dakota, collected June 11-15, 1942

	Ash	Protein
Brookings 1	10.88	11.31
Brookings 2	11.72	11.38
Graton	13.76	11.98
Eureka	17.18	22.58
Highmore	15.80	17.17
Average	14.07	14.89

The Kochia sample collected at Eureka contained the highest percentage of protein, the Highmore sample second highest, and those from Brookings the lowest. When the protein content was high the ash content was also high.

**The Leaf-Stem Ratio.** To determine the leaf-stem ratio two representative plants were obtained from each of five plots in a yield study made at Highmore in 1944. The plants were of the size and age of those shown in Fig. 3. The leaves were clipped from the fine branches and the fine branches from the central stem and each portion dried in an oven at 95°—100° C. for 24 hours. The data in Table 3 show that the Kochia had 62.4 percent leaves and 32.49 percent central stems.

Table 3. Percent of leaves, fine branches, and central stems of two lots of ten representative Kochia plants grown at Highmore, 1944, oven dry basis

Lot	Leaves	Fine Stems	Central Stems
1	62.87	5.44	31.69
2	61.93	4.78	33.29
Average	62.40	5.11	32.49

Piper cites several figures and sources on the ratio of leaves to stems in alfalfa ranging from 22.7 percent to 49 percent.<sup>11</sup> Information cited from Cottrell in Kansas found an average relation of 45 parts leaves to 55 parts stems.

**Composition of Leaves and Stems.** The leaves and stems used in the study (Table 3) were analyzed for ash and protein. The leaves contained 15.05 percent ash and 21.10 percent crude protein; the stems, 11.35 percent ash and 9.3 percent crude protein.

**Leaf Characters.** The long narrow leaves of Kochia are sessile and are resistant to shattering in haying and baling operations. This was especially apparent in the fall of 1944 when Kochia and alfalfa were baled from the stack at Highmore. Both crops had been handled similarly. In the baled Kochia only a few leaves had been broken from the plant whereas in alfalfa most of the leaves had been concentrated in the lower part of the bale.

**Tolerance of Leaves to Shade.** In the several plantings of Kochia it has been found that the leaves stay green and persist in dense shade produced by the profuse growth of a single plant or by the closely spaced plants in a solid seeding. In 1945 the leaves remained green to the base of the plants in late September when the plants were five feet tall in a close-drilled seeding. Retention of leaves is an important characteristic in a forage. Further, it offers a possibility of obtaining dense shade where this factor is desirable in subduing undesirable plants.

<sup>11</sup>"Forage Plants and Their Culture," C. V. Piper, The MacMillan Co., 1935, p. 365.

**Yields of Hay.** Hay yields were recorded from small plots and from acre fields at the Main Station and at Highmore in central South Dakota. The hay yields are presented in Tables 4 and 5.

Table 4. Yields of Kochia Hay in Field Plantings of one and two acres at Brookings and Highmore 1941-1944

BROOKINGS		Year and Crop	HIGHMORE	
Year	Tons per Acre		Cutting	Tons per Acre Total
1941	1.47	1942—1st	.80	.80
		1944—1st	1.07	
		—2nd	1.05	2.12

Table 5. Yields of hay from small plots of Kochia, millet and annual sweet clovers at two locations in South Dakota 1941-1944

BROOKINGS				HIGHMORE	
Crop	T./A. 1941	T./A. 1942	T./A. 2 yr. av.	Crop	T./A. 1944
Kochia, 1st cutting	2.07	1.9	2.0	Kochia, 1st cutting	1.14
2nd cutting	1.90	.0*	.95		
Siberian millet	2.10	1.6	1.8	Siberian millet	1.47
Hibam	1.20	4.8	3.0	Hibam	0.00
Golden Annual Sweet Clover	1.10	2.8	2.0	Golden Annual Sweet Clover	0.00

\* The first cutting was made too low and the stands were killed, hence no second cutting.

The data in Tables 4 and 5 show that Kochia produced 2.4 tons of hay per acre per year at Brookings and 1.3 tons per acre per year at Highmore. Siberian millet yielded 1.8 tons at Brookings and 1.47 tons at Highmore.

Table 5 shows that the annual sweet clovers gave no yield at Highmore in 1944. This was due to severe grasshopper damage to the clover seedlings. Kochia is resistant to damage by grasshoppers, a valuable characteristic in a forage for the Great Plains.

**Yields of Seed.** Portions of several close-drilled plots were harvested for seed in 1945 at Brookings and at Highmore. Plants from representative square yard areas were harvested, placed in grain bags and dried. Each plot was threshed separately and the seed was further dried in the laboratory. The appendages were rubbed from the seed from samples of each lot. An average figure of 26 percent was obtained for the weight of the "chaff" removed by rubbing. This figure was used to reduce the seed weights to "heavy seed weights." The yield of seed was at the rate of 1500 pounds per acre at Brookings and 1450 pounds per acre at Highmore in 1945.

**Drought Resistance.** Kochia has been observed to grow well in situations of limited or low soil moisture. Muenscher states that this species occurs "mostly on dry soils . . ." <sup>12</sup> Drought resistance is a highly desirable characteristic in a forage plant for the Great Plains Region. During the years 1941-1945 the rainfall at Brookings and Highmore in South Dakota has been well distributed throughout the season. It has not been possible, therefore, to gather data on drought resistance. However, many observations by the author and others indicate that Kochia grows well in situations of low soil moisture.

<sup>12</sup>See Footnote 4, Page 6.

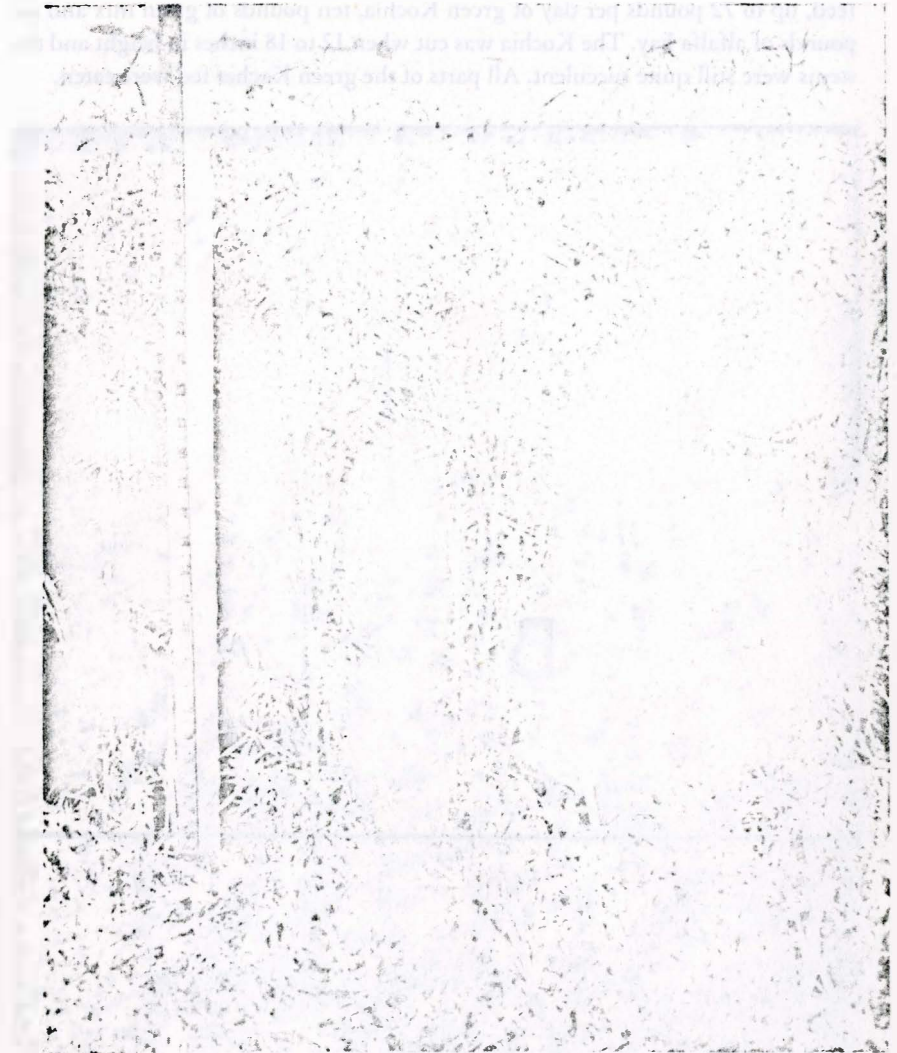


Fig. 3. Kochia plants 22 to 26 inches high at time of first cutting, showing leanness, persistence of leaves and nature of growth.

**Pasturage and Seilage.** Observations on the palatability of Kochia as pasture indicate that it is eaten readily by cattle, sheep and hogs. Animals have been observed eagerly grazing the early spring growth. During the summer of 1943 several pastures were found to be producing mainly Kochia which cattle were grazing as their principal source of feed.

In 1942 a feeding test was run on Kochia cut and fed green. One Holstein cow was fed increasing amounts of fresh Kochia, from 12 pounds per day, plus other

feed, up to 72 pounds per day of green Kochia, ten pounds of grain mix and six pounds of alfalfa hay. The Kochia was cut when 12 to 18 inches in height and the stems were still quite succulent. All parts of the green Kochia fed were eaten.



Fig. 4. A plot of Kochia at Brookings July 6, 1945. (a)—2 inch stubble; (b)—4 inch stubble; (c)—plants in early hay stage, 22 to 26 inches in height.



**Silage.** Silage was made from *Kochia* second growth, 10 to 12 inches in height and from mature plants five feet tall. The silage from both was satisfactory with or without the addition of molasses. Glass milk bottles of one gallon capacity were used for this silage test. After 20 days the silage was judged good.

Samples were analyzed and the data are reported in Table 6.

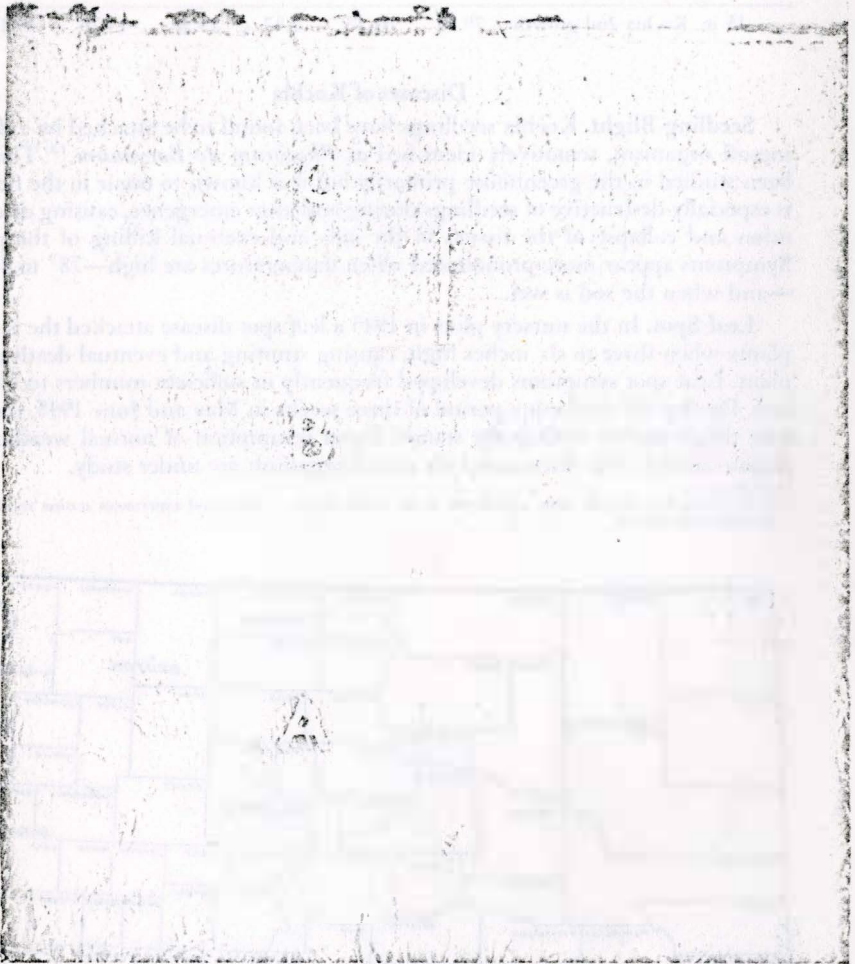


Fig. 5. Same plot as in Figure 4 on August 18. (a)—2 inch stubble, no second cutting. (b)—4 inch stubble gave second cutting of 14 inch height. (c)—*Kochia* plants in full bloom and five feet in height.



Table 6. Composition of silage made from Kochia 60 inches high with or without molasses, and second growth 15 inches tall, no molasses added—1945.

	Moisture Percent	Fiber	Fat	Moisture Free Ash	Basis Protein	N.F.E.
60 in. Kochia no molasses	79.24	31.08	2.07	12.03	17.49	37.33
60 in. Kochia molasses added	76.66	31.20	2.11	12.45	18.01	36.23
Average	77.95	31.14	2.09	12.24	17.75	36.78
15 in. Kochia 2nd growth	79.79	31.13	2.57	13.36	13.76	39.16

### Diseases of Kochia

**Seedling Blight.** Kochia seedlings have been found to be attacked by a damping-off organism, tentatively identified as *Phythium de Baryanum*.<sup>13</sup> This has been studied in the greenhouse primarily but it is known to occur in the field. It is especially destructive of seedlings during and after emergence, causing discoloration and collapse of the tissues of the axis and eventual killing of the plant. Symptoms appear more pronounced when temperatures are high—78° to 85° F.—and when the soil is wet.

**Leaf Spot.** In the nursery plots in 1945 a leaf spot disease attacked the Kochia plants when three to six inches high, causing stunting and eventual death of the plant. Leaf spot symptoms developed frequently in sufficient numbers to kill the leaf. During the cool rainy period of three weeks in May and June 1945, the leaf spot threatened to destroy the stands. Upon resumption of normal weather the disease abated. The disease and the causal organism are under study.

<sup>13</sup>W. F. Buchholz, formerly plant pathologist at the South Dakota Agricultural experiment station studied and identified this disease.

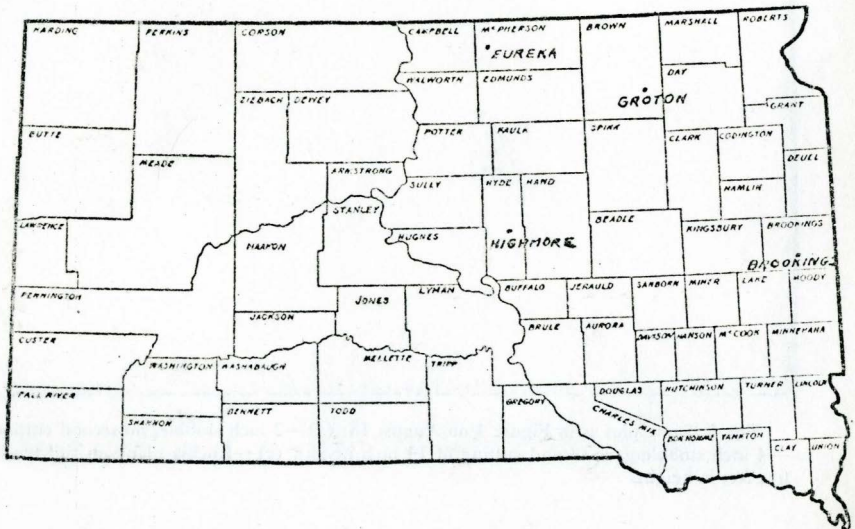


Fig. 6. The four locations in South Dakota from which Kochia was collected and analyzed. Data are in Table 2.

## Management of Wild Stands

*Kochia Scoparia* L. has been growing wild since escaping cultivation as an ornamental. In some situations it may be very aggressive and grow to considerable size. It is especially noticeable in the fall when the plants may be large and coarse. Since it is an annual plant, it is easily controlled by the prevention of seed production. This can be done by cultivation or by mowing at the pre-bud stage.

The seed germinates very early in the spring over a period of two or three months. Small grain and corn have been grown in soil which had been heavily seeded by *Kochia* the previous year. No problem was encountered in east central and central South Dakota when the crop was planted right after thorough cultivation.

Plants when once established can be killed by cutting off at the ground line. Plants in a close stand when 20 or more inches high will be killed if mowed so as not to leave any live branches on the stubble.

## Summary and Conclusions—Part I

1. *Kochia scoparia* (L.) Schrad—an escaped ornamental plant commonly called Burning bush, Summer cypress, Fireball, Belvedere, Mexican fireweed and Fireweed—was observed to grow well in a habitat of limited moisture, and found to produce early an abundant leafy growth high in protein.

2. Plant collections and some of the selections were analyzed and found to contain from 11.34 percent to 22.58 percent protein.

3. Yield tests show that *Kochia* has produced 1.7 tons per acre the first cutting. In 1941 the second growth yielded 1.9 tons per acre.

4. *Kochia* hay possesses a satisfactory hay aroma.

5. Hay produced in 1944 at the Central Sub-station, Highmore, contained 62.4 percent leaves.

6. Seed yields at the rate of 1450 pounds at Highmore and 1500 pounds per acre at the State Agricultural Experiment Station at Brookings were obtained in 1945.

7. In 1944 at Highmore, *Kochia* plants were relatively unharmed by grasshoppers, while annual sweet clover was destroyed.

8. *Kochia* is drought-resistant.

9. *Kochia* produced a satisfactory yield of leafy forage high in protein and medium in crude fiber content.

10. *Kochia* can be made into good quality hay, and in years of forage shortages wild stands of the plant can be utilized as hay. (See part II for information on feed value).

11. A second cutting may be obtained from a stand if the first cutting is made so as to leave live branches on the stubble.

Part II

## Apparent Digestibility, Palatability and Other Feeding Qualities of Kochia Compared With Alfalfa Hay

By E. L. ERICKSON and A. L. MOXON<sup>1</sup>

Kochia was found to possess forage production qualities to a high degree,<sup>2</sup> especially as to yield, drought resistance, high percentage of leaves, resistance to leaf shattering, grasshopper resistance, high protein content, medium fiber content and high palatability.

From the information gathered by 1942, it appeared that Kochia offered promise as a forage plant for South Dakota, especially in dry years when other forage would be insufficient. Many fields have been left idle in past years, and these frequently are covered with a stand of volunteer Kochia. These wild stands could be utilized as feed were the feed characteristics known, and in years of drought would be a valuable source of nutritious feed.

In 1942 sufficient information was available on Kochia to encourage studies of the feed value of Kochia hay. Accordingly, hay was grown at Highmore and at Brookings in 1943 for feeding trials. Information was needed to determine the forage possibilities of Kochia, with a view toward future studies on production, utilization and improvement. The feeding studies were done in cooperation with the Animal Husbandry Department.

Literature pertaining to the plant studies of *Kochia scoparia* L. is reviewed in Part I. No reference has been found concerning the feeding value of Kochia hay. Morrison (Table 7) presents composition and digestibility data on many feeds. The following table presents some averages of standard crops for comparison with the results of the studies reported in this bulletin.

<sup>1</sup>Formerly Assistant Agronomist and Station Chemist, respectively, South Dakota Agricultural Experiment Station. The authors acknowledge with thanks the cooperation and guidance given by the Animal Husbandry and Dairy Husbandry staffs during the course of this work.

<sup>2</sup>Part I, p. 8 to 13.

Table 7. Comparative data on composition and digestibility of several forages from published sources and from data appearing in this bulletin, p.8 and 22

	Dry Matter %	Protein %	Total Dig. Nutritive		Average Total Composition				Digestion Coefficients				
			Nutrients %	Ratio 1:	Protein %	Fat %	Fiber %	N. free Extract %	Ash %	Protein %	Fat %	Fiber %	N. free Extract %
<sup>1</sup> Alfalfa Hay													
All analyses	90.4	10.6	50.3	3.7	14.7	2.0	29.0	36.4	8.3	72	32	43	71
<sup>1</sup> Alfalfa Hay (31-34% Fiber)	90.4	9.6	49.8	4.2	13.5	1.7	31.6	35.9	7.7	71	31	44	70
<sup>2</sup> Alfalfa Hay, stemmy (over 34% fiber)	90.4	8.2	47.5	4.8	12.1	1.4	36.0	33.1	7.8	68	28	45	67
<sup>3</sup> Timothy Hay													
All analyses	88.7	2.9	46.9	15.2	6.2	2.4	30.1	45.0	5.0	46	48	51	58
<sup>4</sup> Crested Wheat Hay	89.81	1.74	43.08	23.76	4.80	1.49	33.98	43.88	5.66	36.33	20.33	50.83	53.33
<sup>5</sup> Crested wheat, 10"	93.45	3.82	60.04	14.72	7.95	2.22	27.73	48.90	6.65	48.00	57.00	68.50	76.33
<sup>6</sup> Alfalfa	90.	8.66	52.43	4.55	13.02	.91	37.06	31.92	7.09	59	-3.45	53.1	60.3
<sup>7</sup> Kochia	90.	8.24	51.55	4.86	12.66	1.04	25.66	38.92	11.72	58.5	15.3	46.35	68.4

<sup>1</sup>From "Feeds and Feeding" Twentieth Edition by F. B. Morrison, The Morrison Publishing Co., Ithaca, N. Y. by permission of the author.

<sup>2</sup>Sotoia, Jerry, Jour. Ag. Res. Vol. 61, No. 4, pp. 303-312.

<sup>3</sup>Data from tables 11 and 12, pages 21 and 22 this bulletin; changed from dry matter basis to 90 percent dry matter so as to be comparable to other hay.

## Palatability Trials

Following the observations on plant characters which indicated the forage possibilities of Kochia, the question of palatability became of prime importance. To obtain a general idea as to whether animals would consume Kochia, small quantities of fresh and cured forage were fed to dairy cows, beef cows and wethers in 1941. These animals ate both the green and cured Kochia readily. In order to obtain further information on palatability a quantity of Kochia was harvested from a vacant lot in Brookings, where a fairly pure volunteer stand was growing. This was mowed on July 1 and coked on July 2. Subsequently the hay was weighed and stored in the dairy barn.

In August this hay was fed to a milk cow to obtain data on the amount an animal would consume. It was found that the palatability of Kochia was suffi-

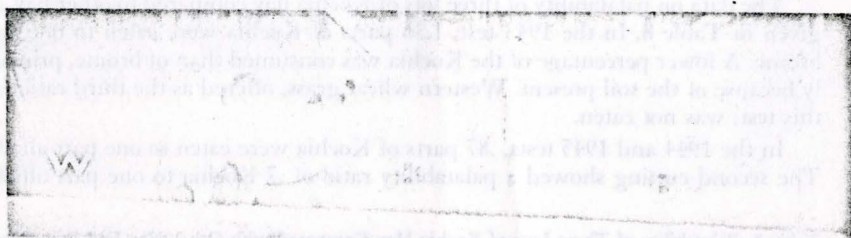


Fig. 7. The beginning of the first palatability test, 1943, showing the three filled feed racks. 1. Western wheatgrass hay, 2. Kochia hay, 3. Brome hay.

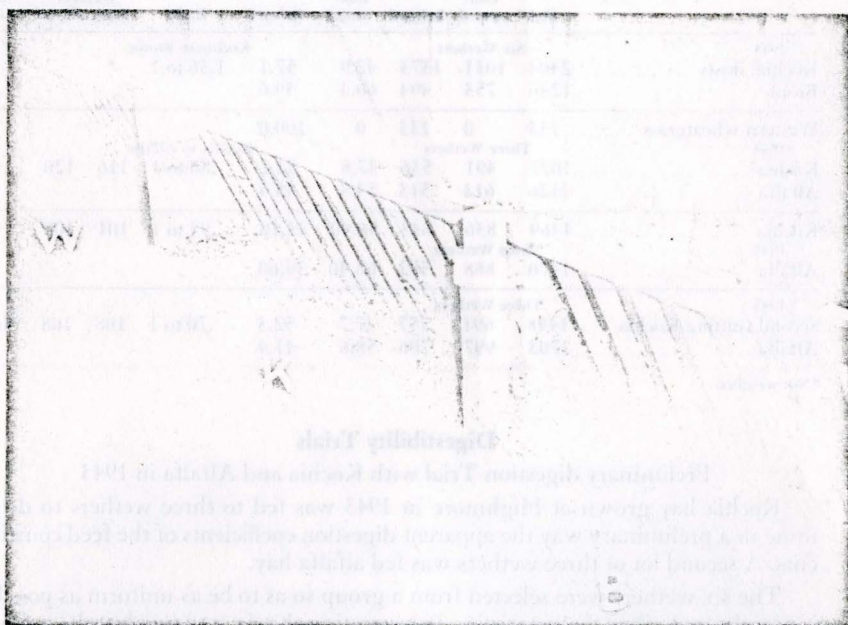


Fig. 8. Ten a.m. of second day of test, showing the relative amounts of hay consumed.



ciently satisfactory to justify further study the following year. Accordingly in 1942, one acre was seeded to Kochia at Brookings and one acre at Highmore. Seed secured from the wild population grown at Brookings in 1941 was used. Forage produced on these plots was used in further tests of palatability.

Subsequent studies on palatability were made in 1943-1945. Six wethers were fed free choice, Kochia, brome and western wheat grass hay in a slatted feed rack in the fall of 1943 (Fig. 7). In the 1944 and 1945 trials Kochia hay was compared with alfalfa hay using three wethers in each lot. In these tests the hay was weighed and placed in the feed rack. Once each day the coarse refused portion was removed from the rack and feed box trough below the rack and weighed. The Kochia hay used in 1943 was of lower quality than the other hays because of dust and the presence of soil.

The data on palatability of three lots of Kochia hay compared to other hay are given in Table 8. In the 1943 test, 1.36 parts of Kochia were eaten to one part brome. A lower percentage of the Kochia was consumed than of brome, primarily because of the soil present. Western wheat grass, offered as the third ration in this test, was not eaten.

In the 1944 and 1945 tests, .87 parts of Kochia were eaten to one part alfalfa. The second cutting showed a palatability ratio of .7 Kochia to one part alfalfa.

Table 8. Palatability of Three Lots of Kochia Hay Compared with Other Hay Fed Free Choice to Wethers for 10 days

	Gms. per wether per day			Percent		Ratio	Av. weight of Wethers		
	Fed	Con- sumed	Refused	Con- sumed	Refused		Start	Finish	Change
1943									
Six Wethers									
Kochia, dusty	2404	1031	1373	42.9	57.1	1.36 to 1	*		
Brome	1246	753	494	60.4	39.6				
1944									
Three Wethers									
Kochia	1027	491	536	47.8	52.2	.80 to 1	116	120	+4
Alfalfa	1126	613	513	54.4	45.5				
1945									
Three Wethers									
Kochia	1469	836	633	56.90	43.10	.94 to 1	101	108	+7
Alfalfa	1470	888	582	60.40	39.60				
1945									
Three Wethers									
Second Cutting Kochia	1448	691	757	47.7	52.3	.70 to 1	108	108	None
Alfalfa	1703	997	706	58.6	41.4				

\*Not weighed

### Digestibility Trials

#### Preliminary Digestion Trial with Kochia and Alfalfa in 1943

Kochia hay grown at Highmore in 1943 was fed to three wethers to determine in a preliminary way the apparent digestion coefficients of the feed constituents. A second lot of three wethers was fed alfalfa hay.

The six wethers were selected from a group so as to be as uniform as possible in weight and other characteristics. In separating the six into two lots the animals were chosen by lot.



Individual pens 4 feet by 18 feet were provided with a feed box in one end. Water was available and changed morning and evening.

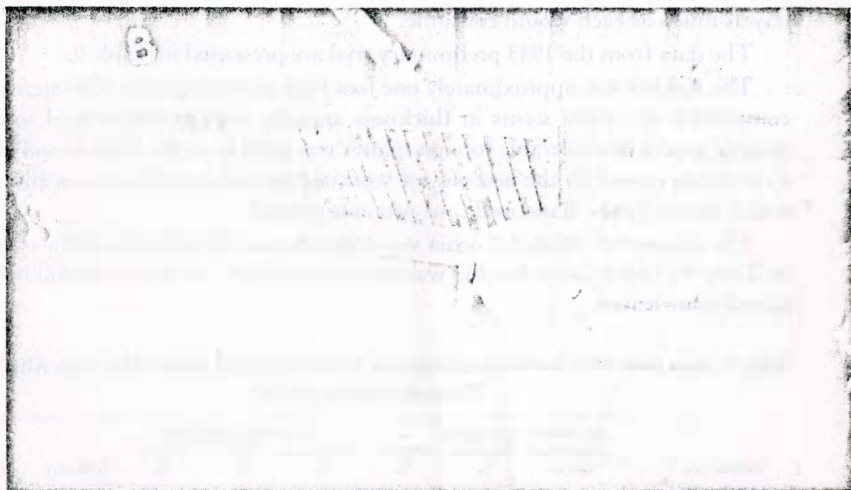


Fig. 9. The beginning of the second five-day period in palatability test. 1. Erone hay, 2. Western wheatgrass hay, 3. Kochia hay.

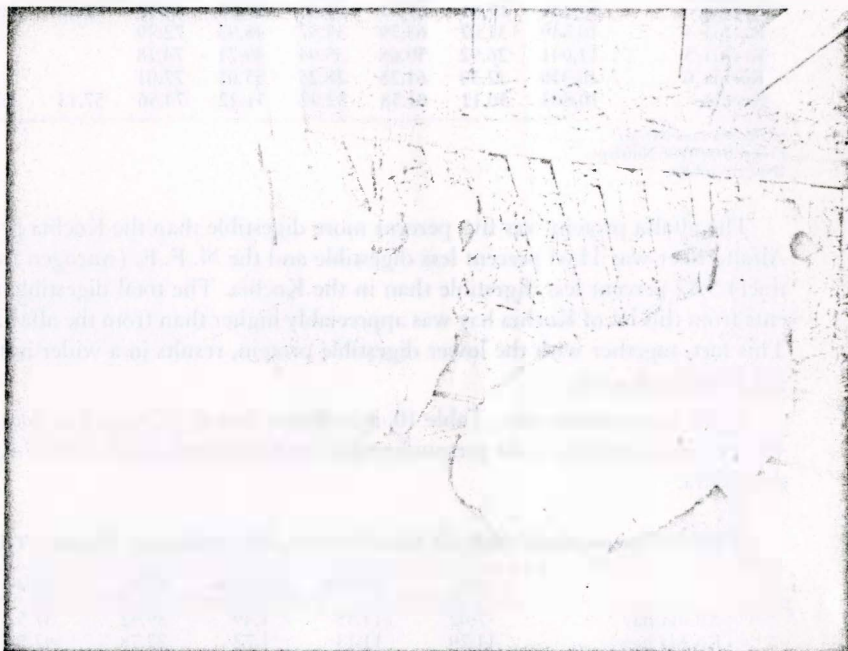


Fig. 10. Just after first feeding time in second five-day period when the position of the feeds were shifted, showing Kochia being consumed.

Wethers in pens 1, 2 and 3 received alfalfa hay and those in pens 4, 5 and 6 received Kochia hay. A preliminary feeding of five days on the hay was done to accustom the animals to the feed to be tested. The wethers were fed twice each day as much as each would consume.

The data from the 1943 preliminary trial are presented in Table 9.

The Kochia was approximately one foot high at cutting time. The stems were comparable to alfalfa stems in thickness and the foliage was judged to be 30 percent green. Considerable foreign matter was present in the form of soil lumps, a condition caused by the necessity of working the soil several times in June with a disk to reduce the stand and thus promote growth.

The amount of refused Kochia was twice that of the refused alfalfa as shown in Table 9. This refused Kochia was composed mainly of stems and soil but contained some leaves.

Table 9. Data from 1943 Preliminary Digestion Trial Comparing Kochia Hay with Alfalfa Hay Through Ten-Day Period

Wether No.	Dry Matter		Protein %	Digestion Coefficient			T.D.N.†	N.R.‡
	Consumed Grams	Refused %		E. Extract %	Fiber %	N.F.E.* %		
Alfalfa 1	11,127	11.05	65.05	15.52	39.40	66.45		
Alfalfa 2	16,098	16.96	67.15	24.77	39.75	70.71		
Alfalfa 3	10,051	19.43	67.99	10.96	39.60	68.90		
Average	10,425	15.81	66.73	17.08	39.58	68.69	51.33	1:4.29
Kochia 4	10,639	31.02	63.79	34.57	48.93	72.49		
Kochia 5	11,041	26.92	59.68	35.94	49.71	74.18		
Kochia 6	10,910	32.39	61.28	28.25	55.01	77.01		
Average	10,863	30.11	61.58	32.92	51.22	74.56	57.13	1:7.34

\*Nitrogen Free Extract

†Total Digestible Nutrients

‡Nutritive Ratio

The alfalfa protein was five percent more digestible than the Kochia protein. Alfalfa fiber was 11.64 percent less digestible and the N. F. E. (nitrogen free extract) 5.87 percent less digestible than in the Kochia. The total digestible nutrients from this lot of Kochia hay was appreciably higher than from the alfalfa hay. This fact, together with the lower digestible protein, results in a wider nutritive ratio for the Kochia.

In the composition data, Table 10, it is shown that the Kochia hay contained 4.77 percent more ash, 11.64 percent less fiber and 10.06 percent more N.F.E. than the alfalfa.

Table 10. Composition of Feed and Refused Portion, 1943 Preliminary Digestion Trial

	Ash	Protein	E. Extract	Fiber	N.F.E.
Alfalfa hay	7.02	14.55	1.49	39.42	37.52
Kochia hay	11.79	11.13	1.72	27.78	47.58
Alfalfa hay refused	5.16	9.15	1.38	54.13	30.18
Kochia hay refused	13.65	9.39	1.28	32.89	42.79

## Digestion Trials, 1944

The 1944 digestibility trials with wethers were conducted in a basement room of the College Livestock Pavilion. A feeding crate three feet high, one and one-half feet wide and five feet long was placed in each 8 x 10 foot pen. A feed drawer was placed in one end of the crate in front of a stanchion arrangement through which the animal reached the feed. The crate was open at one end to admit the animal. The feces were collected in a feces sack with harness arrangement as described by McCall, et al.<sup>3</sup>

**The Feed.** In 1944 alfalfa and wild Kochia hay were produced at the Central Experiment Farm, Highmore, for additional feeding tests. The alfalfa hay was made and stacked in good weather. Rainy weather prevailed while the Kochia hay was being made. One soaking rain fell on the Kochia when it was in the windrow, necessitating turning previous to stacking. Because rain threatened the second time, the Kochia hay was stacked before field curing was complete. This fact, together with too compact stacking, caused some molding in the stack, especially in the lower half.

In the fall the hay was baled and stored indoors. The alfalfa hay was very dry and the leaves tended to be shattered and concentrated in the lower portion of the bale. The Kochia hay retained the leaves on the stems to a high degree in baling. In the baling process it was necessary to discard badly molded portions so as to have a fair quality hay. The lower portion of the stack was discarded because of spoilage. Sufficient Kochia hay of fair quality was obtained for feeding tests. The composition of the hay and refused portion appears in Table 11.

Table 11. Composition of the Kochia Hay, Alfalfa Hay and the Refused Portions 1944  
Digestion Trials with Wethers, Moisture-Free

Trial	Ash %	E. Extract %	Protein %	Crude Fiber %	N.F.E. %
Alfalfa Hay					
Trial I .....	8.41	1.04	14.34	46.71	35.50
Trial II .....	7.34	.98	14.66	41.65	35.43
Average .....	7.88	1.01	14.47	41.18	35.47
Kochia Hay					
Trial I .....	14.16	1.32	15.81	25.06	43.65
Trial II .....	11.87	.98	12.33	31.98	42.84
Average .....	13.02	1.15	14.07	28.52	43.25
Alfalfa Refused					
Trial I .....	7.44	.92	11.27	44.53	35.84
Trial II .....	6.90	.73	11.10	49.22	32.05
Average .....	7.17	.83	11.19	46.88	33.95
Kochia Refused					
Trial I .....	11.06	.94	10.90	38.27	38.86
Trial II .....	9.22	.65	7.70	41.05	38.38
Average .....	10.14	.80	9.30	41.15	38.62

The data in Table 11 compare the Kochia hay and alfalfa hay used in the 1944 trials. Using the average of the two analyses it is evident that the Kochia hay was higher in ash than the alfalfa hay by 5.14 percent; in fat by .14 percent and in N.F.E. by 7.78 percent. On the other hand, Kochia was lower than alfalfa in

<sup>3</sup>Technical Bulletin 418, Montana Agricultural Experiment Station, by Ralph McCall, et al.

protein content by .4 percent and in fiber by 12.66 percent.

In comparing the refused portions from the two hays the same relationships in composition prevail except in the ether extract which was lower in the Kochia refused portion.

The wethers were fed for 15 days and the data from the last 10 days used in the calculations. At the end of the first run the feeds were transposed. Again the last ten days data were used in the calculations. Samples of hay, refused portions and feces were saved only during the 10-day period. Composite samples of these were analyzed by the Experiment Station Chemistry Department. Official methods were used.<sup>1</sup>

The data from the 1944 digestion trials are given in Table 12.

Table 12. Summarized data on a ten day reversal trial of digestibility of Kochia Hay and Alfalfa Hay, 1944

D.M.	ALFALFA					D.M.	KOCCHIA					
	Coefficients of Digestibility						Coefficients of Digestibility					
Consumed Grams	D.M. Refused %	Protein %	E. Extract %	Fiber %	N.F.E. %	Consumed Grams	D.M. Refused %	Protein %	E. Extract %	Fiber %	N.F.E. %	
	TRIAL I						TRIAL II					
Wether 1	12,570	22.50	64.07	-5.66	56.99	64.89	10,708	36.17	63.94	+0.64	59.92	76.01
Wether 4	11,018	32.97	65.52	+1.44	61.09	69.25	13,285	39.87	63.21	+1.48	59.88	71.98
Wether 5	11,128	22.47	63.54	-6.47	55.52	64.37	10,755	37.57	59.90	-3.86	54.66	71.12
Average	11,572	25.81	64.38	-3.56	57.86	66.17	10,583	37.87	62.35	-1.74	58.22	73.04
	TRIAL II						TRIAL I					
Wether 2	10,948	33.48	64.75	-18.95	56.48	72.42	9,747	45.24	72.81	34.47	46.65	80.11
Wether 3	10,612	37.26	67.67	-12.51	58.87	67.82	10,179	39.75	64.71	34.69	45.88	79.50
Wether 6	12,249	31.36	72.79	+19.05	65.20	75.07	11,696	31.10	66.79	47.27	42.05	77.70
Average	11,257	34.07	68.07	-4.14	60.18	71.77	10,541	38.69	68.10	35.48	44.86	79.10
Av. for both Trials	11,416	29.94	66.22	-3.85	59.03	68.97	10,612	38.28	65.23	17.45	51.54	76.07

The data in Table 12 show the comparative feeding value of Kochia hay and alfalfa hay. This experiment also gives the digestion coefficient for each animal on both Kochia and alfalfa.

First, it is desirable to compare the averages between groups of three animals on the same feed. The digestibility of the components in Trial I alfalfa are in close agreement with those in Trial II as evidenced by the average digestion coefficients. Also, the summary Table 13 of the total digestible nutrients and the nutritive ratio for Trials I and II on alfalfa show close agreement.

In the case of the ether extract digestibilities, several negative values were obtained. In the two groups fed Kochia hay, Trial I gave a positive figure for digestibility of ether extract while Trial II gave a negative result.

The total digestible nutrients and N.R. (nutritive ratio) summary (Table 13) show close agreement, except the N.R. for Trial I, Kochia, is narrow, being 1:4.3. It will be noted that in this trial the hay analysis showed the protein content to be higher than in Trial II.

The digestibility of crude fiber in Kochia is 13.36 percent higher in Trial II than in Trial I. In this instance the greater portion of this difference is accounted for in the higher content of crude fiber in the Trial II sample.

<sup>1</sup>1940 Methods of Analysis, Association of Official Agricultural Chemists.

Table 13. Total Digestible Nutrients and Nutritive Ratio of Kochia and Alfalfa Calculated from Data in Table 12

	ALFALFA		KOCCHIA	
	T.D.N.	N.R.	T.D.N.	N.R.
Trial I .....	56.21	1:5.07	56.99	1:4.3
Trial II .....	60.31	1:5.04	57.58	1:6.5
Average .....	58.26	1:5.06	57.28	1:5.4

Composition of the Feces. Table 14 records the composition of the feces collected from the 1944 digestion trials. The moisture content of the feces from the six wethers fed Kochia hay is 16.52 percent greater than the moisture content of the feces from the alfalfa fed group. The feces, as collected, generally were soft from the Kochia group. A tendency toward scouring was noted in one wether. This is an important point and it is possible that more mature hay would exhibit this tendency to a lesser degree.

The ash content is 4.89 percent higher in the feces from the Kochia fed group. It is not known whether this higher ash content is responsible for the higher moisture content of the feces.

Table 14. The Composition of the Feces from the Wethers in Trials I and II (Moisture-free)

	ALFALFA					KOCCHIA							
	H <sub>2</sub> O %	Ash	E. Extract	Protein	Crude Fiber N.F.E.	H <sub>2</sub> O %	Ash	E. Extract	Protein	Crude Fiber N.F.E.			
Feces No. 1 .....	62.28	12.12	2.73	13.34	41.52	30.30	Feces No. 1 .....	82.39	16.58	3.52	16.35	30.55	33.00
Feces No. 4 .....	62.20	12.72	2.91	14.63	40.58	29.15	Feces No. 4 .....	78.34	17.87	3.12	15.88	26.96	35.97
Feces No. 5 .....	67.42	11.05	2.73	13.38	42.45	30.39	Feces No. 5 .....	80.36	16.48	3.12	17.96	28.66	33.78
Feces No. 2 .....	64.87	13.41	3.27	15.14	42.04	26.14	Feces No. 2 .....	80.56	18.78	3.70	18.67	26.13	32.72
Feces No. 3 .....	64.08	12.81	3.20	13.84	39.23	36.92	Feces No. 3 .....	79.67	17.41	3.25	21.30	27.69	30.65
Feces No. 6 .....	60.73	11.23	2.83	14.08	42.42	29.44	Feces No. 6 .....	79.36	15.56	2.80	17.92	33.14	30.58
Average .....	63.60	12.22	2.94	14.07	41.37	29.49	Average .....	80.12	17.11	3.28	18.01	28.85	32.73

### Preliminary Digestion Trial with Second Cutting Kochia

The second cutting of Kochia obtained from the two-acre field at Highmore in 1944 was used in a single 10-day feeding test to obtain preliminary information

Table 15. Preliminary Comparison of Second Cutting Kochia Hay and Alfalfa Hay 1945, Ten-day Trial

	D.M.		Digestion Coefficients			
	Consumed grams	Refused %	Protein %	E. Extract %	Fiber %	N.F.E. %
Alfalfa 1 .....	10,919.10	30.27	62.41	—43.25	56.02	64.37
Alfalfa 4 .....	8,565.93	42.64	65.15	—55.99	61.30	61.86
Alfalfa 5 .....	9,946.53	36.36	65.97	—34.30	64.36	67.19
Average .....	9,811.	36.42	64.51	—44.51	60.63	64.47
Kochia 2 .....	7,229.54	44.41	60.19	38.06	43.65	77.10
Kochia 3 .....	8,247.88	39.11	59.82	41.96	38.39	74.39
Kochia 6 .....	9,393.94	33.12	61.17	45.94	46.19	73.04
Average .....	8,290.	38.88	60.39	41.99	42.74	74.88
	T.D.N.		N.R.			
Alfalfa .....	55.68		1:3.67			
Kochia .....	55.24		1:7.36			



Table 16. Composition of Hay and Refused Portions from Digestion Trial with Second Cutting Kochia and Alfalfa 1945, Moisture-free

	Ash	Protein	E. Extract	Fiber	N.F.E.
Alfalfa Hay .....	9.72	18.47	1.03	36.63	34.15
Alfalfa Refused .....	14.95	17.97	1.17	32.08	33.83
Second Growth					
Kochia Hay .....	11.92	10.94	1.81	26.56	48.77
Kochia Refused .....	9.70	8.55	1.19	36.65	43.91

on the value of the second cutting. The data in Tables 15 and 16 show the results of this trial.

Table 15 shows that wethers 2, 3 and 6 consumed an average of 152 grams or 15 percent less second cutting Kochia hay than alfalfa hay. The central stem was dry and very hard as well as sharp, especially at the place where it was cut when the first crop was harvested. The three to six side branches which grew from this section of the axis were fine but not as leafy as the first crop. The hay was palatable, but the wethers had difficulty eating the coarse central stem. This introduced a mechanical difficulty since each branch had to be eaten separately and chewed off the central stem. This factor is believed to be responsible for the lower intake of second growth Kochia rather than a lower palatability.

Table 16 gives the comparative composition of the two hays fed, showing the alfalfa higher in protein and fiber, while the Kochia is higher in ash, fat and N.F.E.

In digestibility coefficients, Table 15, the alfalfa is superior in protein and fiber, while the second cutting Kochia had a higher digestibility coefficient for ether extract and the nitrogen free extract. In the summary of total digestible nutrients, the hays are about the same and the N.R. of second cutting Kochia hay is much wider than that of the alfalfa hay.

It is indicated that second cutting Kochia may make hay of good feeding value. Further study is needed in obtaining the second cutting, however, to eliminate the problem with the central stems which caused mechanical difficulty for sheep in consuming the hay.

#### Kochia as a Maintenance Feed for Wintering Beef Heifer Calves

Kochia hay and alfalfa hay were fed to heifers for 55 days. The results are shown in Table 17.

Table 17. Comparison of Kochia Hay and Alfalfa Hay for Wintering Beef Heifers. March 7, 1945, to May 1, 1945

	Alfalfa 1st cutting	Kochia 1st cutting
Initial weight, pounds .....	371	367
Final weight, pounds .....	436	419
Days Fed, pounds .....	55	55
Daily Gain, pounds .....	1.18	.95
Total Feed Fed, pounds .....	717	717
Total Feed Refused, pounds .....	60	115
Percent Feed Refused .....	8.4	16.0
Amount Fed Daily, pounds .....	13.0	13.0
Amount Consumed Daily, pounds .....	11.9	10.9

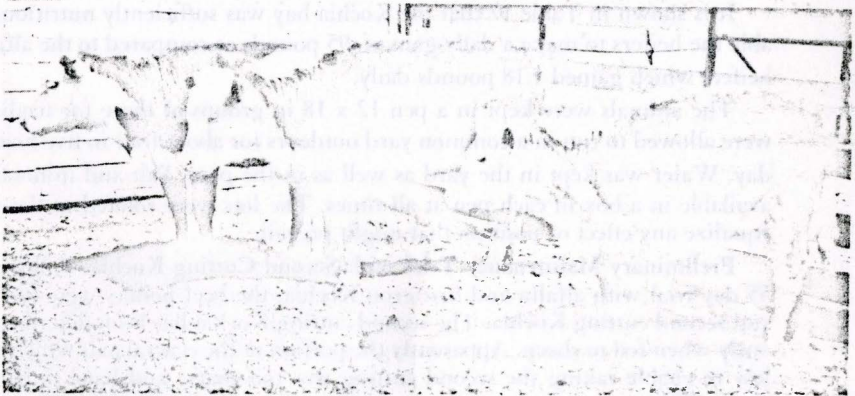


Fig. 11. Lot 1 at end of 55 day trial after consuming 657 pounds alfalfa hay per head and gaining an average of 65 pounds.

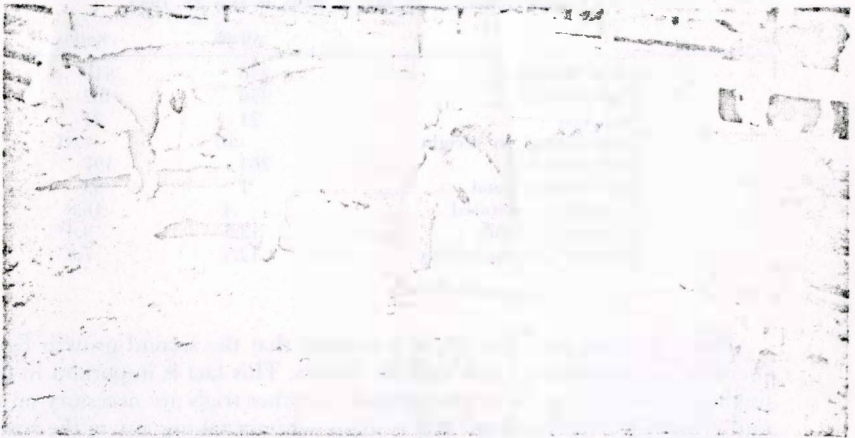


Fig. 12. Lot 2 at 55 days after consuming 600 pounds Kochia hay and gaining an average of 52 pounds.

It is shown in Table 17 that the Kochia hay was sufficiently nutritious to enable the heifers to make a daily gain of .95 pounds as compared to the alfalfa-fed heifers which gained 1.18 pounds daily.

The animals were kept in a pen 12 x 18 in groups of three for feeding and were allowed to run in a common yard outdoors for about four to five hours each day. Water was kept in the yard as well as in the pens. Salt and minerals were available in a box in each pen at all times. The lots were rotated in the pens to equalize any effect of position that might prevail.

**Preliminary Maintenance Trial with Second Cutting Kochia.** Following the 55 day trial with alfalfa and first crop Kochia, the beef heifers were fed alfalfa and second cutting Kochia. The second cutting Kochia has been described previously when fed to sheep. Apparently the portion of the central axis which was cut low to enable raking the second cutting was too coarse and hard to be readily eaten. This factor was more detrimental to consumption by the heifers than by the wethers. The data are given below:

Table 18. Comparison of Second Cutting Kochia Hay and Alfalfa Hay as a Maintenance Feed for Beef Heifer Calves, May 1, 1945, to May 22, 1945

	Alfalfa	Kochia
Initial Weight .....	436	419
Final Weight .....	450	402
Days Fed .....	21	21
Daily Change in Weight .....	.67	-.81
Total Feed Fed .....	263	197
Total Feed Refused .....	1	33
Percent Feed Refused .....	.4	16.8
Amount Fed Daily .....	12.5	9.4*
Amount Consumed Daily .....	12.5	7.8

\*Less fed because previous feeding not cleaned up.

From the data in Table 18, it is evident that the second growth Kochia as used was not satisfactory as a feed for heifers. This fact is important in devising methods of obtaining the second growth. Further trials are necessary on the second growth Kochia when the hay is made without taking any of the coarse portions of the plant axis, or by processing the hay.

**Effect of Kochia on Milk Flavor.** In the fall of 1942, Dr. G. C. Wallis, then Associate Dairy Husbandman, supervised the feeding of Kochia hay to a dairy cow and the collecting and grading of the milk samples. The hay was fed after each milking and milk samples were taken approximately 10 to 12 hours later in half-pint bottles and tightly sealed with caps. The samples were scored by a committee from the Dairy Department and descriptive terms given where the score was below 23, which is considered excellent for market milk, while 25 represents a perfect score.

Milk produced when alfalfa hay was fed was described as feed-unclean three times, slight feed, once. Milk produced when Kochia hay was fed was described as slight feed twice and from the green Kochia as stale feed or weed flavor four times. This latter occurred when the cow was consuming 72 pounds of green Kochia per day, plus the grain mix.

### *Forage from Kochia*

In summarizing the effect of Kochia on milk flavor, there was no objectionable flavor to the milk from the Kochia hay. A weed or stale feed flavor was recorded when the cow consumed 72 pounds of green Kochia per day.

**Table 19. Summary of the scores of milk produced while alfalfa hay, Kochia hay and Kochia provided the roughage in the ration, Brookings, 1942.**

	Number of times milk received indicated score						
	20	20.5	21	21.5	22	22.5	23
Alfalfa Hay .....		1	1	3	1	1	1
Kochia Hay .....						1	2
Green Kochia .....			1	5	1		

### Summary and Conclusions—Part II

1. A preliminary digestion trial in 1943 indicated Kochia hay more digestible than alfalfa hay in fat, fiber and nitrogen free extract. Alfalfa protein was percent more digestible than Kochia protein.

2. The total digestible nutrients of the Kochia hay fed in 1943 tests was 5 percent and 51.33 percent for the alfalfa.

3. Kochia hay in a reversed trial in 1944 was nearly equal to alfalfa in apparent digestibility of protein, and superior in fat and N.F.E. digestibility. The fiber in Kochia was 7.49 percent less digestible than the fiber in the alfalfa.

4. The fiber content of Kochia hay was 12.66 percent less than in the alfalfa hay.

5. In a second trial Kochia hay was nearly equal to alfalfa hay in total digestible nutrients, 58.26 for alfalfa and 57.28 for Kochia.

6. The Kochia hay caused soft feces in wethers and tended toward scouring in one animal.

7. Second cutting Kochia hay in a preliminary trial gave 55.24 percent digestible nutrients and alfalfa 55.68 percent.

8. When fed as a maintenance ration in wintering beef heifer calves, alfalfa hay produced a daily gain per head of 1.18 pounds and first cutting Kochia .95 pounds, over a 55 day period.

9. Feces from heifers fed only Kochia hay were normal with no tendency toward scouring.

10. Second cutting Kochia as used was unsuitable for heifer calves because of the presence of a portion of the first growth plant stem from which the second cutting grew.

11. The palatability of Kochia was 1.36 to 1 for brome hay. Western wheatgrass of fair quality was not eaten during the 15-day period when Kochia, brome and western wheatgrass were available free choice to six wethers.

12. First cutting Kochia was .87 as palatable as alfalfa hay.

13. Second cutting Kochia was .7 as palatable as alfalfa hay to wethers.

14. Kochia hay harvested at 20 to 26 inches in height and before flowering was palatable and nutritious forage.