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Phenotypic Variations of *Kochia scoparia*

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PHENOTYPIC VARIATIONS OF *KOCHIA SCOPARIA*

by

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Kenneth M. Benson

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INTRODUCTION

Kochia scoparia (L.) Schrad. has had limited use as a forage crop during the past fifteen years in parts of the western United States, Canada, and Argentina. Erickson and Moxon (1947) reported kochia* to be a good emergency feed for sheep and cattle during dry years in South Dakota. Salguero (1946) said that this species could be utilized in Argentina as silage or pasturage if harvested before flowering. Bell, et al. (1952) in Saskatoon, Canada studied this species in a comparison with other introduced plants and reported that it seemed to have desirable nutrient characteristics for livestock roughage. Plummer (1949) reported beef cattle in Ephraim, Utah had eaten and gained normally on kochia hay.

Investigations of kochia by Erickson and Moxon (1947), Bell, et al. (1952), and Plummer (1954) indicated that this plant has a protein content which compares favorably with legumes. Data in the literature indicates the stage of maturity when kochia gives the best combination of palatability, yield, and protein content is just before anthesis.

Some soils of Utah and other arid states have a concentration of soluble salts which prevent or inhibit the growth of most cultivated species. Economical reclamation of many of these soils is not possible due to poor drainage, impervious subsoils, the high cost of amendments, and availability and/or quality of water for leaching purposes. An approach for more economical production of forage on these soils is better adapted species such as kochia.

Kochia is a member of the Chenopodiaceae family of which some members are halophytes e. g. Salicornia, Allenrolfea, and Sueada.

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*Hereafter kochia will refer to Kochia scoparia (L.) Schrad.

Plummer (1955) reports he had observed kochia doing well on soils which contained 10,000 parts per million of soluble salts.

Erickson of South Dakota collected seed from wild stands of kochia and the literature indicates that currently available seed is from this common origin. He investigated growth habits, forage qualities, and forage and seed yields.

The author and others have observed a great phenotypic variability in unselected stands of kochia. There is no available evidence in the literature that this species has ever been selected for specific phenotypes. Naylor (1955) in Canada has been doing some selection of phenotypes but has not published his results.

The objectives of this investigation are to classify the plants into specific types, to observe the rate of growth of individual plants, and to sample some of the plants in order to compare protein content of the different types, and to observe any other characteristics which might be of value in selecting forage types.

REVIEW OF LITERATURE

Current and past research

Kochia is a plant of comparatively recent cultivation as a forage crop. Erickson and Moxon (1947) made their preliminary investigations in South Dakota between the years 1940-1946. Plummer (1954) reported his work in cooperation with Mr. John K. Olson at Ephraim, Utah. Bell, *et al.* (1952) started their work in Canada in 1949. Salguero (1946) reports that kochia had been used for feed in Argentina. Robertson (1954) in Nevada stated that investigations are being conducted with kochia and *Bassia hyssopifolia* to determine their value on range lands. Some workers from other areas have reported preliminary investigations were made but were not continued because kochia was not considered to be of great value as a forage when compared to other adapted species for their locality.

There are research projects currently being conducted with kochia. Robertson (1954) reported that the University of Nevada Range Department investigated the range possibilities of kochia on wet, salty soils. Peake (1954) said preliminary observations are being conducted with this species in Alberta, Canada. Naylor (1955) has a kochia breeding project which is being conducted at the University of Saskatchewan at Saskatoon, Canada. He has made phenotypic selections for earliness of maturity and leaf:stem ratio. Also he has been working on the genetic variation controlling the ash content of individual plants. Coupland (1954) states that the early frost in the fall has proven to be a problem in getting seed matured in Canada. Plummer (1954) has conducted investigations in connection with the Intermountain Forest and Range Experiment Station at Ephraim, Utah.

Botanical characteristics

This species is cited in the literature by many names. Some of these names are summer cypress, belvedere, burning bush, Mexican fireweed, fireweed, and fireball.

Kochia belongs to the Chenopodiaceae family. Davis (1952) describes this species as a plant much branched, the branches erect or ascending and very leafy. Bailey (1949) said the leaves of this species are linear or even narrower and entire and crowded, The fruit is a utricle in which the seed is free from the pericarp. The flowers are bisexual and are all alike on the same plant. The calyx has five incurved lobes which develops wings in the fruit. There are five stamens which are exserted. This plant usually has two stigmas. There is no corolla. The perianth is sessile. Rydbert (1917) describes kochia as an annual, the stems sparingly pubescent or glabrous, the branches are strongly ascending, and the plants grow 30-100 centimeters high. Fernald (1950) said kochia is an erect pyramidal or ovoid topped upright, and grows up to 150 centimeters high. Muenscher (1935) states this species reproduces by seeds. It is found in waste places, ballast grounds, and occasionally in fields.

Nutriet qualities

A summary of nutrients determinations by the following investigators is listed in table 1. Erickson and Moxon (1947) in South Dakota investigated chemical composition, palatability, yield of forage and seed, and overall feeding value of kochia. Bell, et al. (1952 and 1954) in Canada have made nutrient evaluations and determinations with kochia. Plummer (1954) reported some nutrient values of kochia. The results of some digestion trials by Bell, et al. (1952) and Erickson and Moxon (1947) comparing kochia with some other forages are summarized in table 2.

Some properties about the feeding value of kochia are noted here. Zahnley (1954) reported two instances in which kochia had been toxic to cattle in Kansas. The first incident he cited was to beef cattle which had grazed on kochia in a railroad stock yard while awaiting shipment to market. Some of the animals died and death was attributed to some kind of poison in the green kochia. Zahnley said that the other time milk cows which had fed on kochia hay were distressed and milk production decreased for a few days.

Salguero (1946) reported that kochia might be toxic if harvested after anthesis. Clare (1952) said kochia was among a list of plants which were suspected of or known to produce hepatogenous photosensitivity in animals.

Zahnley (1954) reported in one feeding trial in Kansas that kochia was harvested as a silage. The animals fed on this feed did not show symptoms of toxicity and seemed to gain normally.

Erickson and Moxon (1947) did not report toxic affects of kochia silage or hay when fed to beef cattle, sheep, or dairy cows in South Dakota. Bell, et al. (1952) said that no toxic effects were observed in Saskatchewan, Canada feeding tests. Bell (1954) did say that when succulent kochia was fed to yearling holstein

Table 1. Nutrient analysis of Kochia scoparia at three locations in the United States and Canada.

Size of Plants	Year	Stage of Maturity	Dry Matter	Crude Protein	Ash	Fiber	Nitrogen free extract	Location
ins.			percent	percent	percent	percent	percent	
18-26	1940		100	13.18	21.30	19.54	43.61	South Dakota
18-26	1943		100	11.13	11.79	27.78	47.58	South Dakota
18-26	1944	First cutting	100	14.07	13.02	28.52	43.24	South Dakota
18-26	1944	Second cutting	100	11.55	12.03	26.56	48.77	South Dakota
60			79.24	17.49	12.03	31.08	37.33	South Dakota
15		Second cutting	79.79	13.76	13.36	31.15	39.16	South Dakota
16-20	1950	Pre-bloom	86.9	18.7	16.7	17.1	32.3	Saskatoon, Canada
36-40	1950	Stems up to ½" in diameter	87.4	9.8	10.7	31.1	34.5	Saskatoon, Canada
48		Early bloom	100	13.0	10.68	-	-	Saskatoon, Canada
12-24		Pre-bloom	100	22.99	23.37	16.10	35.90	Ephraim, Utah
48-72		Late bloom	100	17.71	14.5	28.85	36.40	Ephraim, Utah
60-84		Seed nearing maturity	100	9.58	11.46	31.88	43.4	Ephraim, Utah

Table 2. Total digestible nutrients and digestive coefficients for *Kochia scoparia* at two locations.*

Height	Stage of Maturity	Total digestible nutrients	Digestive coefficient Protein	Ether extract	Fiber	Nitrogen free extract	Location
ins.		percent					
18-26	First cutting	57.13	61.58	32.92	51.22	74.56	South Dakota
18-26	Second cutting	55.24	60.39	41.99	42.74	74.66	South Dakota
16-20	Fine stemmed, leafy	57.00	83.00	-	49.00	68.00	Saskatoon, Canada
36-40	Stems up to ½" in diameter, leafy	48.00	69.00	-	46.00	57.00	Saskatoon, Canada

*As determined on wether lambs.

heifers that it seemed to act as a laxative if it was the only roughage in the diet. He suggested the probable reason was due to the high ash content of the feed.

Tucker (1954) states that kochia is being used in Colorado as a feed. It has been used on areas which had been drought stricken and many of the usual forages did not produce enough feed for the animals. Kochia as a forage is cited in Farm Journal (1954). It is being used in Colorado by producers of beef and sheep. Plummer (1949) said beef cattle had consumed and gained normally on kochia hay in Sanpete County, Utah.

Culture and adaptability

Erickson and Moxon (1947) said kochia seeds germinated early in the spring. They reported the seedlings were highly resistant to freezing. Bell, *et al.* (1952) said that kochia was leafy down to the base of the stem during its early stages of growth when the plants were less than three feet tall. Hughes, *et al.* (1951) reported that the shaded leaves were green to the base of the plant when kochia plants were five feet tall. Foury (1952) said that under dry conditions *K. scoparia* grew to heights greater than 100 centimeters in Morocco. *K. indica* grew only twenty-five to thirty centimeters under the same habitat. Bell, *et al.* (1952) reported that when the kochia plants grew above three feet that the stems became hard and woody.

Plummer (1954) said that kochia planted on Mr. John K. Olsen's farm near Ephraim, Utah, had grown well on saline soils. He said that the plants had grown best where there was a high water table during the early summer or where supplementary irrigations could be applied. Plummer stated that this species will not grow well if the water remains constantly high throughout the growing season. Plummer (1955) said kochia had been observed to grow well in moist soil with 10,000 parts per million of soluble salts. The author and others have observed kochia plants growing in areas of Utah which are known to contain high concentrations of soluble salts.

Kochia has been introduced as an ornamental to Utah and has spread so that it can be found in many parts of the state. It can be commonly found growing in waste places which include ditch banks, roadsides, railroad right of ways, and unmowed yards or fields. This species is adapted to most soils but does not seem to be a good competitor with many species.

METHODS OF PROCEDURE

The phenotypes which are expressed in a unselected source of kochia seed have shown great variability. Inquiries were made in the spring of 1954 about seed sources and the kochia seed sold by Porter Walton Company of Salt Lake City, Utah, was the only major source available. The available evidence indicated that this seed was from unselected progeny of the original South Dakota trials and that seed lots being planted commercially and experimentally in North America were originally from this same source.

The seedings were made on May 3, 1954, on the Evans Farm (forage experimental farm) south of Logan, Utah, on a Salt Lake silty clay loam soil. Fifteen rows approximately 300 feet long were planted. The plantings were made in a solid stand within the row and spaced three feet between rows. Most of the seedlings emerged within one week and were thinned three weeks after planting. The plants were thinned to one plant approximately each three feet within the row.

A modified completely randomized block design was used. The plants observed were numbered consecutively up and down the rows in the field. Every fifth plant was specially marked to be used for protein determination. The plants used to measure the growth rate were all of the threes and eights, e.g. 3, 8, 33, 58, 73, etc. Plant samples for protein analysis were collected on July 1, July 17, August 3, and August 23. All heights measurements were made on these same dates.

The growing season in Utah during the summer of 1954 was hot and dry. Some of the weather data for the Utah State Agricultural College Weather Station is summarized in tables 3 and 4. The plots were irrigated twice. The first was made the day the seeds were planted and the second in early July.

The plant samples for protein determination were collected by cutting a complete branch or several lateral branches from the plant. This portion of the plant was used because the future samplings were to be made from the same plant at three other stages of maturity. The plant samples were air dried, ground in a hammermill, and were analyzed for crude protein by the official Gunning method as determined by the American Society of Agricultural Chemists (1950).

There was no data available in the literature to determine whether this species was cross or self fertilized. For this reason some preliminary selfing and crossing investigation were made. This was done by using paper bags to cover branches of selected plants. Brown kraft bags and white parchment selfing sleeves (figure 1) were used by placing one of each on an individual branch of each selected plant. Some lumite and crinolin covers (figure 2) were made to cover whole plants. The flowering behavior and setting of seed was observed under these covers.

Seed samples were collected from the plants in the field a few days before they were mature. The samples finished ripening in brown kraft bags. Seed samples were collected from each plant which had previously been used for protein determination, from each of the plants which had branches which were selfed and crossed, and

Table 3. Monthly precipitation at the Utah State Agricultural College for five months during 1954.*

	Rainfall in inches during				
	May	June	July	August	September
Amount of rainfall	.80	1.34	.16	.04	1.97**
Departure from normal	-1.22	+.30	-.41	-.42	-

*Data from Climatological Data for Utah (1954).
**Data for Greenville Farm, Utah State Agricultural College Experimental Farm in North Logan, Utah

Table 4. The high, low, and average temperatures (°F.) for each of five months during 1954 at the Utah State Agricultural College.

	Temperature during				
	May	June	July	August	September
High	87	95	97	97	87
Low	27	34	43	36	32
Average	59.2	61.1	74.1	69.6	61.2

Data from Climatological Data for Utah (1954).

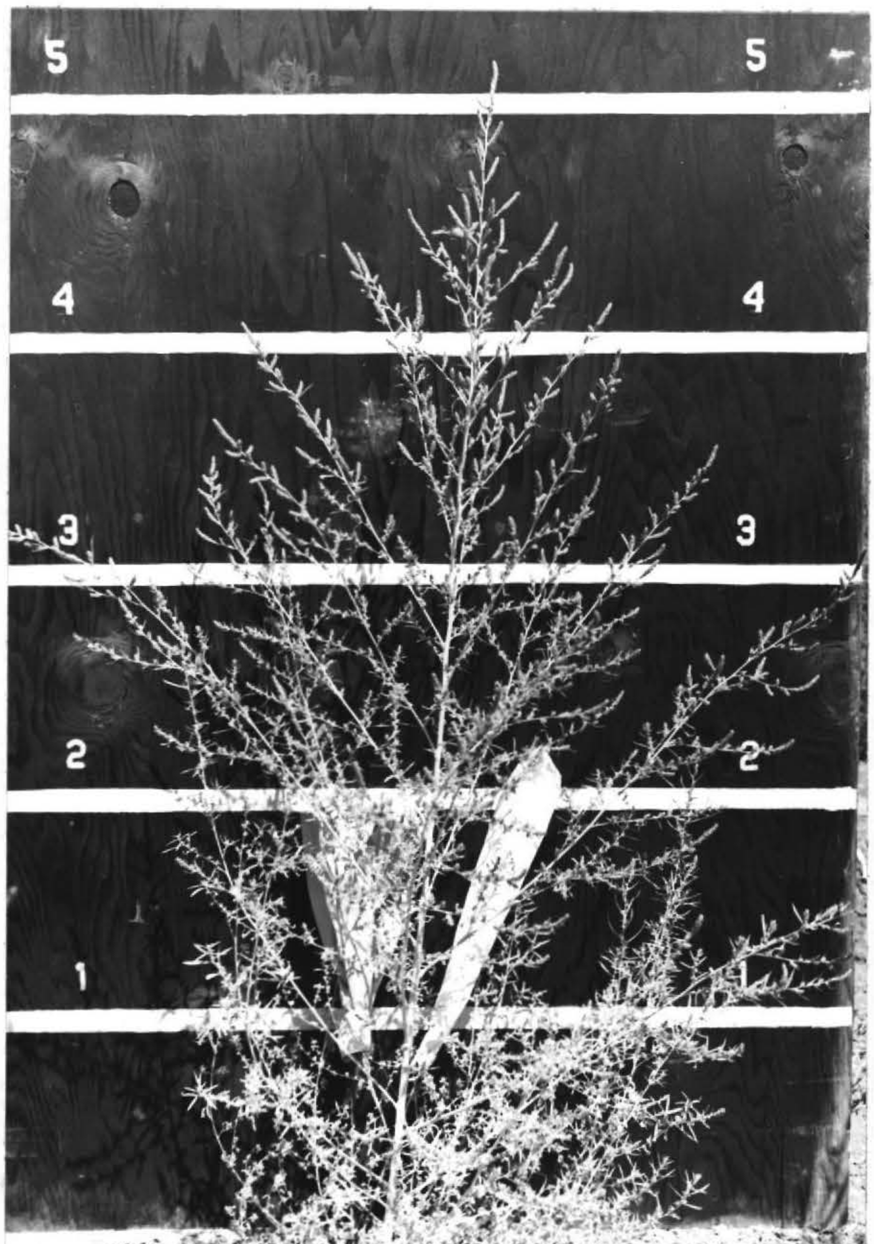

Figure 1. Kochia scoparia plant with brown kraft bag and white parchment selfing sleeve used for self pollination.

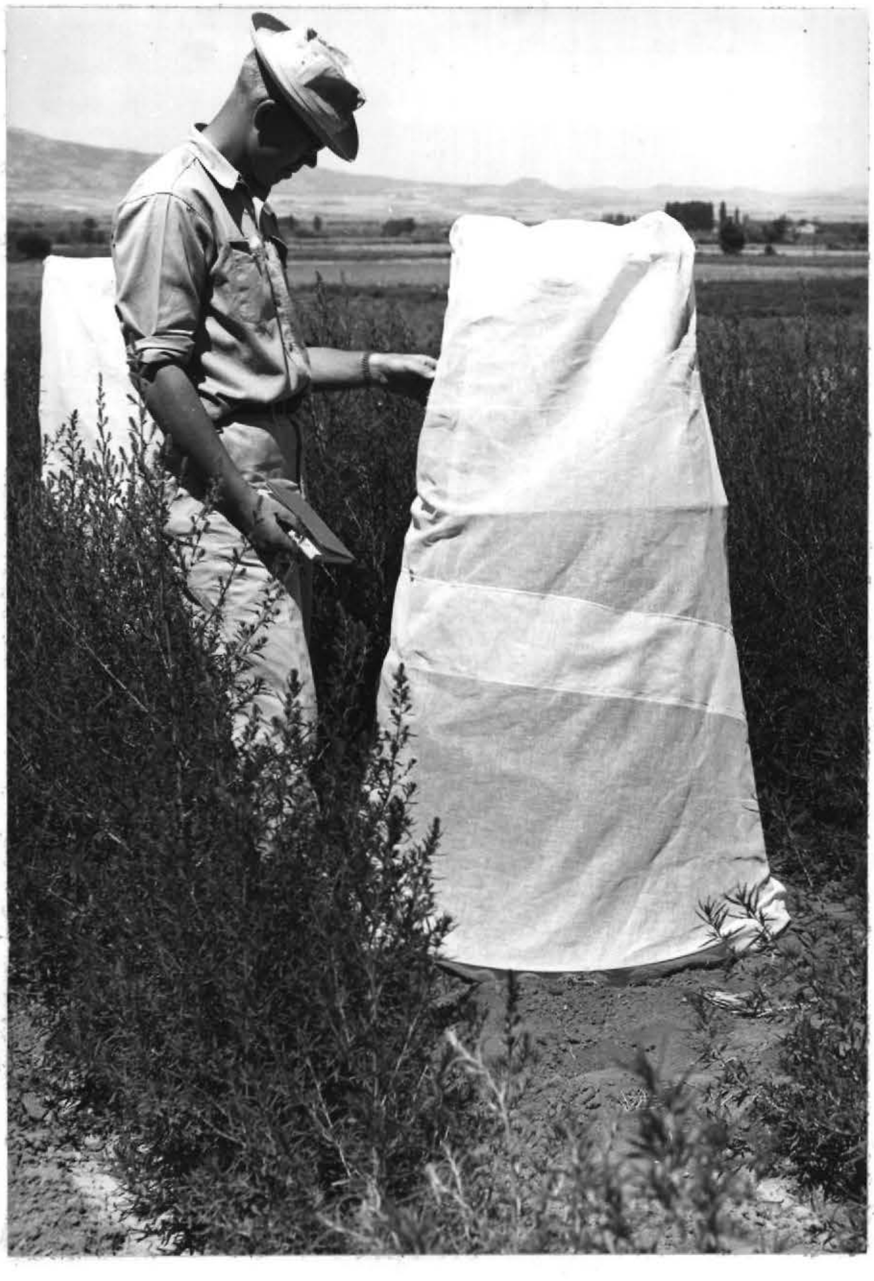

Figure 2. Crinolin hood covering Kochia scoparia plants for self pollination.

from each of the plants which were covered by a lumite or crinolin hood, and from other plants which had some special character for future use.

The plants were classified into three groups according to their morphological appearance. These groups were (1) leafy, globosa, lateral branches originating near the base of the plant (figures 3, 4, and 5), (2) intermediate which had large central stems, plants somewhat ovoid, and foliage somewhat open (figure 6 and 7), and (3) pyramidal or triangular plants with large central stems and openly exposed foliage (figure 8).

Other plant characteristics which might be of future use with this species were observed.

Figure 3. Two Kochia scoparia plants classified as globosa type. Pre-anthesis photograph taken July 20, 1954.

Figure 4. Two *Kochia scoparia* plants classified as globosa type. Post-anthesis photograph taken August 30, 1954.

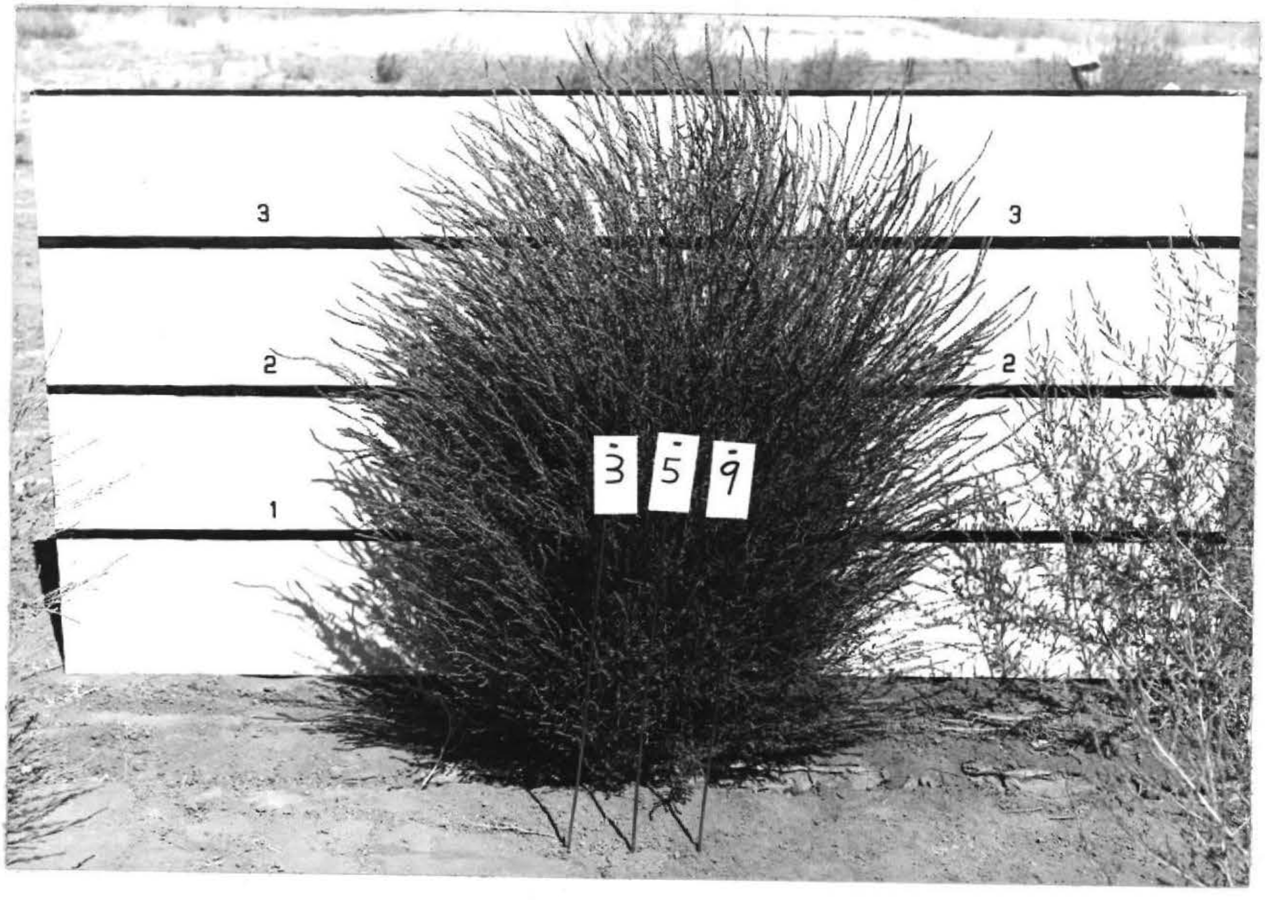

Figure 5. A globosa type plant of Kochia scoparia. Post-anthesis photograph taken August 30, 1954.

Figure 6. A Kochia scoparia plant classified as intermediate. Pre-anthesis photograph taken July 20, 1954.

Figure 7. A Kochia scoparia plant classified as intermediate. Post-anthesis photograph taken August 30, 1954.

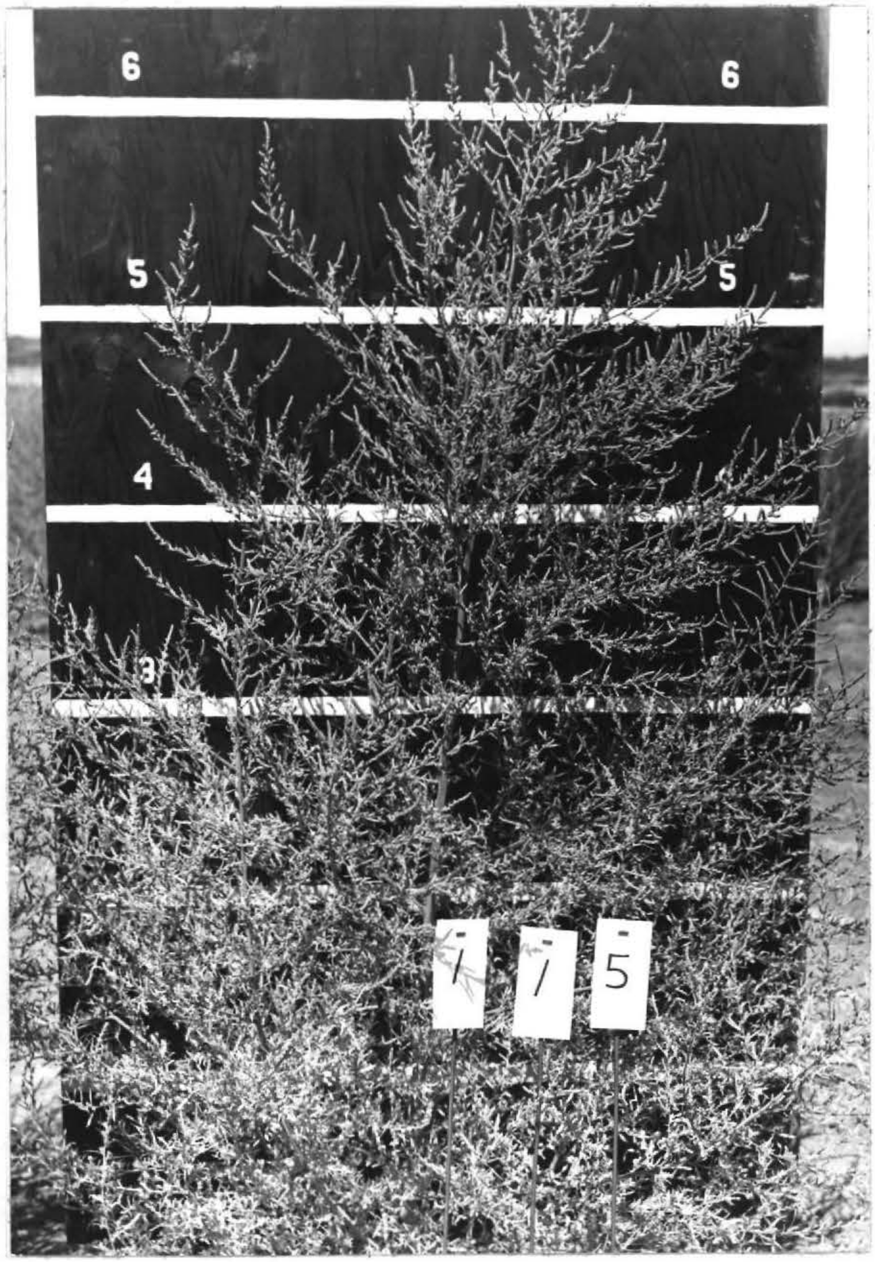

Figure 8. A Kochia scoparia plant classified as pyramidal or triangular. Post-anthesis photograph taken August 30, 1954.

RESULTS AND DISCUSSION

The phenotypic differences in kochia which were observed in this study have also been referred to by Naylor (1955). This Canadian author is making selections similar to those which are anticipated under the Utah program.

The rate of growth of kochia plants was observed for two separate sets of data. One of the groups were those plants from which the samples were collected for protein. The average values are shown in table 5 and figure 9. A test of difference between types is reported in table 6. The other group which was observed for height were plants which were allowed to grow without having any foliage removed. The results of these data are summarized in table 7. The rate of growth of these plants is summarized in figure 9. A test of difference between types is summarized in table 8.

The rate of growth of the seedlings was slow during May and June. The first measurements were made on July 1. Later measurements were made on July 17, August 3, and August 23. The plants began to bloom during the latter part of July and continued blooming until approximately August 10. There was distinct expression of different growth habits among the different type of plants during July. The triangular type plants developed the largest central stem and lateral branches. The intermediate types were also intermediate in the size of the stems and the globosa type plants were smallest

Table 5. Average height of *Kochia scoparia* plants which had some lateral branches removed.

Date measured	Height in inches of plants classified as		
	Triangular	Intermediate	Globosa
July 1	16.97	16.39	17.25
July 17	38.27	35.10	35.16
August 3	56.36	51.32	48.91
August 23	58.56	53.05	50.41

Table 6. Comparisons of plant heights of three different phenotypic groups of *Kochia scoparia* plants which had some lateral branches removed.

Date measured	Calculated t value when comparing		
	Triangular and intermediate	Triangular and globosa	Intermediate and globosa
July 1	1.03	.25	.79
July 17	2.61*	1.81	.03
August 3	3.39**	3.95**	1.24
August 23	3.54**	4.35**	1.29

*Significant at the .05 level
**Significant at the .01 level

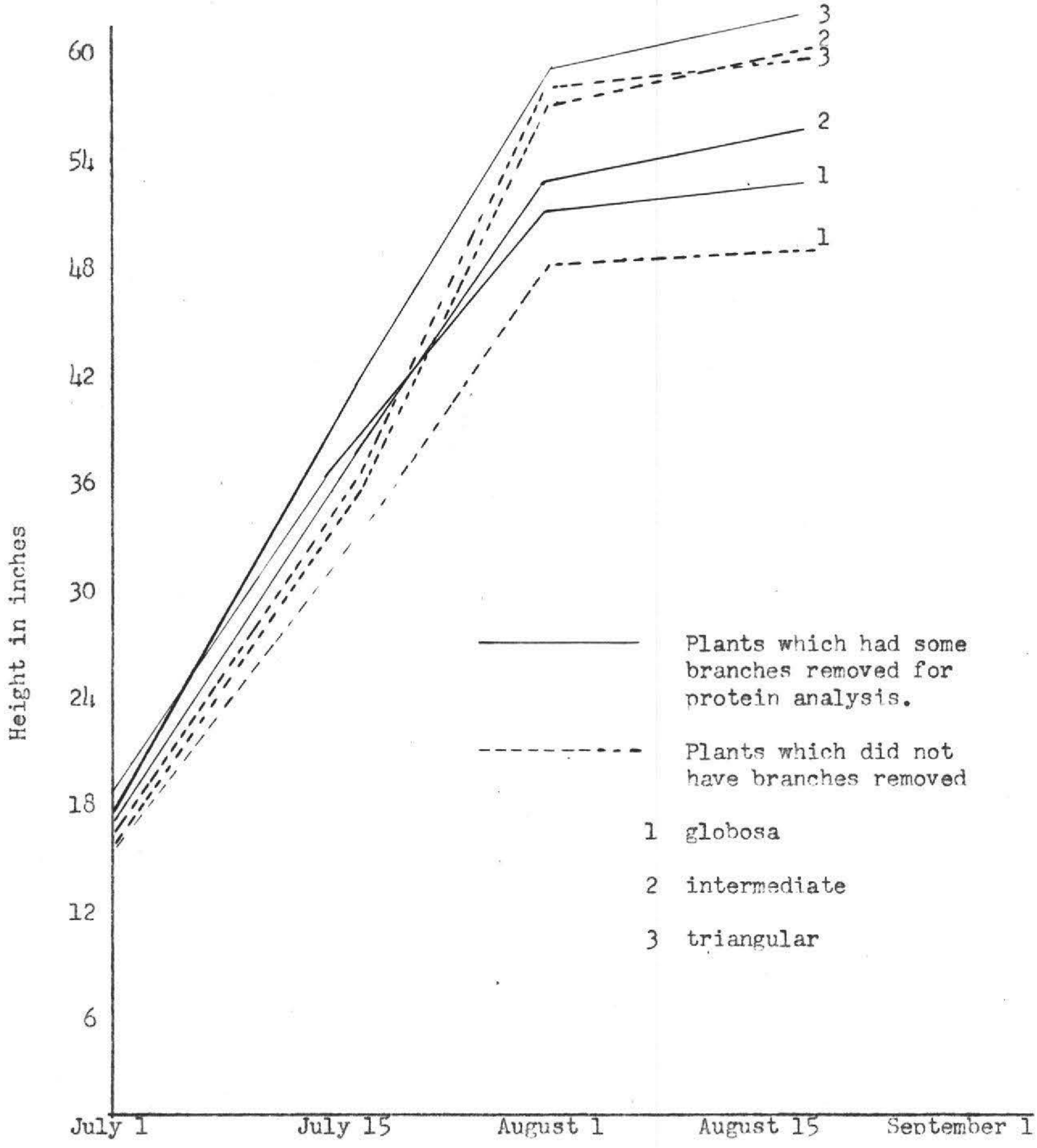

Figure 9. Rate of growth of *Kochia scoparia* plants at the Evans Farm, Logan, Utah.

Table 7. Average height of *Kochia scoparia* plants which did not have branches removed.

Date measured	Height in inches of plants classified as		
	Triangular	Intermediate	Globosa
July 1	14.67	15.00	14.62
July 17	34.53	34.40	31.00
August 3	55.60	55.31	47.12
August 23	57.28	57.36	47.37

Table 8. Comparisons of plant heights of three different phenotypic groups of *Kochia scoparia* plants which did not have branches removed.

Date measured	Calculated t value when comparing		
	Triangular and intermediate	Triangular and globosa	Intermediate and globosa
July 1	.46	.05	.35
July 17	.09	1.38	1.36
August 3	.15	3.05*	3.17*
August 23	.04	3.62**	3.88**

*Significant at the .05 level
**Significant at the .01 level

and most leafy. At the time of the first measurement all the types were approximately the same height but when the period of rapid growth began the triangular and intermediate types grew more rapidly than did the globosa types. None of the plants regardless of type increased much in size after they reached the blooming stage. The total new growth after anthesis was only a few inches.

These results indicate that the globosa types are significantly shorter at stages of maturity near anthesis and later. However the intermediate types were not consistant in the results in both sets of data. The criteria used to classify them might have been in error.

An attempt was made to determine if there was a significant difference between the different types of plants in crude protein content at the same stage of maturity. The hypotheses was that the globosa type plants would contain more protein than the pyramidal or triangular types.

The nitrogen content was determined by the Gunning method and the crude protein percentage was calculated as prescribed by Winton and Winton (1945) by multiplying the nitrogen content by the constant 6.25. The average values of crude protein are listed in table 9.

These calculated values were grouped according to the way they had been classified in the field. A different number of observations within each group necessitated the use of group comparisons. The hypotheses that the groups of plants at the same date of harvest were significantly different with regards to protein content was tested by computing the t values which are

Table 9. Average protein content of lateral branches of three phenotypes of *Kochia scoparia* plants at four dates of harvest.

Date harvested	Average percent crude protein of		
	Triangular	Intermediate	Globosa
July 1	23.45	24.06	23.79
July 17	17.27	17.33	18.06
August 3	12.94	13.16	13.69
August 23	9.37	9.64	9.40

Table 10. A comparison of lateral branch crude protein content of three phenotype groups of *Kochia scoparia* plants.

Date harvested	Calculated t value when comparing		
	Triangular and globosa	Triangular and intermediate	Intermediate and globosa
July 1	.65	1.80	.47
July 17	1.383	.13	1.21
August 3	1.40	.55	.88
August 23	.07	.94	.56

None of these values were significant

summarized in table 10.

This sampling procedure did not show significant differences between plant types in crude protein content. However if the whole plant had been used, including the central stem, there might have been a difference in crude protein content, especially for the later sampling dates.

The protein content of the plants in this investigation were comparable with those reported by Erickson and Moxon (1947), Bell, et al. (1952 and 1954), and Plummer (1954). These other investigators measured protein content of composite samples from many plants. The current investigation indicated that kochia contains a high percentage of crude protein at maturity stages before anthesis but that this declined rapidly with increasing maturity, especially after anthesis.

Although there were no feeding trials on any of the plants reported in this thesis some observations are noted on kochia growing west of Perry, Utah, on saline soils. The field had been planted to several species of forages to observe their performance on saline lands. Beef cattle which grazed this forage ate most of the species readily. The kochia plants which grew there were nearly completely eaten (figure 10). These kochia plants were consumed by the animals just before anthesis. There were no toxic effects observed similar to those mentioned by Zahnley (1954), Salguero (1946), and Clare (1952).

Bell, et al. (1952), Plummer (1949 and 1954), Peake (1954), Robertson (1954), and Naylor (1955) indicate that the seed source being currently used in the United States and Canadian research is

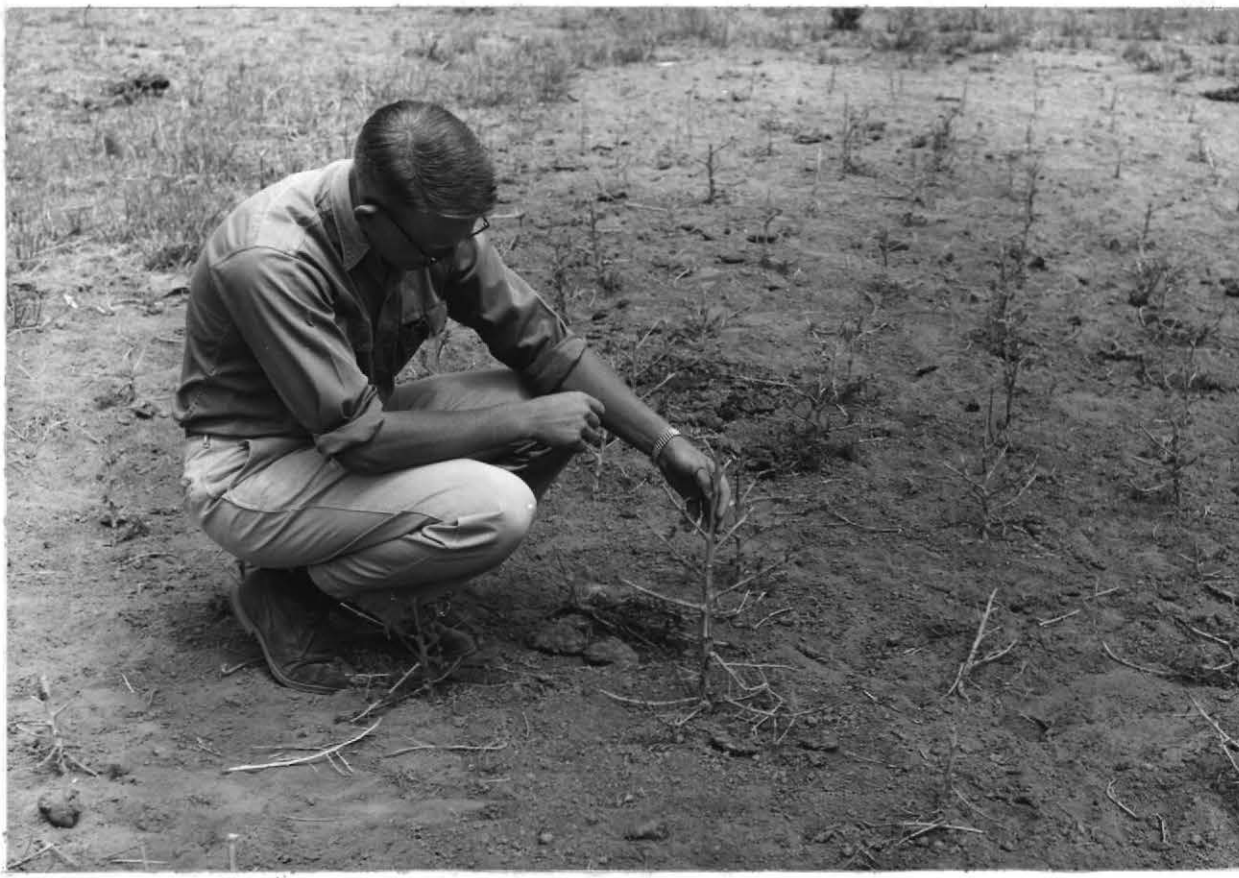

Figure 10. Stem residues of Kochia scoparia plants after they had been eaten by cattle. Perry, Utah, July 1954.

from common origin. The common source was wild stands in South Dakota (Erickson and Moxon 1947). There have been no reports of toxicity of any of the feed produced from this seed source. A possible explanation of the difference is terminology. Although the same generic and species names are used they might actually be referring to different ones. Also soils, stage of maturity (Salguero 1946), and methods of feeding e. g. hay, silage, or pasture might be possible explanations for different results.

Some observations of the kochia in the field indicated that on areas where wild morning glory, Convolvulus arvensis, had been growing that the kochia plants were retarded. Although the wild morning glory was cultivated out several times there was a visual reduction in total kochia growth. This might indicate the need of nitrogen in rather large amounts by kochia.

Some observations were made on three rows of the kochia plants which had been fertilized with ammonium nitrate. The rate of application was approximately 150 pounds of available nitrogen per acre. The fertilizer was applied in early July and was irrigated soon after. The plants responsed to this fertilizer application by an increased density of foliage.

The behavior of the flowering and seed set of the open pollinated and selfed plants was observed. There was no seed produced on the branches which were covered with brown kraft bags and the amount of seed which formed under the parchment selfing sleeves was somewhat less than on open pollinated branches. The seed produced inside of the lumite and crinolin hoods was normal and production might have been greater than under open pollination. This might have been due to the greater foliage production which occurred under these hoods.

Some insects were observed in the field but during anthesis there were no members of the Hymnoptera family which could be seen among the blossoms. There were some members of the Diptera and Ephemeroptera families which were active in the flowers during anthesis. The tremendous amount of pollen produced indicated that cross-pollination was effected by wind. No references were found to indicate the mode of pollination.

There were noticeable differences in the time that the red pigments began to show in different plants. Some began in early August and others were not changed from the normal green when frost occurred in September. Bailey (1949) reported that it is typical of this species to turn a characteristic red after the seed is formed. This might indicate a trend that the different phenotypes have a different time to maturity. This might be a possible characteristic on which to select for date of maturity.

Many questions have been raised through this preliminary investigation. Some points which require further research are listed here.

1. How uniform are the progeny from self-pollinated and cross pollinated plants. How variable are the phenotypes of progeny from the same parent plant.

2. Do the progeny seem to segregate or are the phenotypes similar to the parent plants.

3. Is hybrid vigor expressed when comparing plants from seed which resulted from cross pollinating with those which were self pollinated.

4. Can the date of anthocyanin appearance be used as a

measurement of maturity date.

5. A study of harvesting and feeding methods and procedures.

6. Variation of specific nutrient content of individual plants e. g. ash and crude fiber.

SUMMARY

I. Data for 106 individual plants of *Kochia scoparia* (L) Schrad. which included height of plants and protein content of lateral branches were collected at four stages of maturity during the summer of 1954. The plants were grown on the Evans Farm south of Logan, Utah. An unselected commercial seed source was used to get as much variability in expression of phenotypes as possible. The plants were classified as globosa, intermediate, and triangular according to morphological characteristics. The lateral branches for protein sampling were harvested at two dates before anthesis, once during anthesis, and once after anthesis. Height measurements were made on these sampling dates.

2. Two separate sets of height data were taken. One set was for the 106 plants which had part of their foliage removed for protein analysis and the other set was for 106 plants which did not have foliage removed.

3. Comparisons of the phenotypic groups at the same date of harvest indicated that there was not a significant difference in crude protein between any of the groups compared although there was great variability within groups.

4. There was a rapid decline in protein content of all groups as they matured. There was no measurable difference between any of the types at the same date of maturity.

5. Comparisons of average height of the phenotypic groups

indicate some differences. The plants before anthesis were approximately the same height in all three groups. The globosa type plants were significantly shorter than the triangular types at the later stages of maturity.

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APPENDIX

APPENDIX

TABLE I. Height and protein content of *Kochia scoparia* plants at four stages of maturity.

Plant No.	Plant Type	July 1 Height	July 1 Protein	July 17 Height	July 17 Protein	August 3 Height	August 3 Protein	August 23 Height	August 23 Protein
		ins.	percent	ins.	percent	ins.	percent	ins.	percent
5	3*	20	23.00	40	22.37	58	13.56	59	9.31
10	3	18	22.81	36	19.44	51	12.94	52	10.06
15	3	15	27.31	36	21.19	55	15.75	56	13.56
20	2	19	22.25	40	19.50	60	13.00	62	9.94
25	3	13	22.31	30	19.37	50	17.06	57	10.94
30	3	15	24.87	36	19.06	55	15.56	58	10.50
35	2	16	25.00	34	17.81	48	15.25	51	11.44
40	3	21	21.43	41	16.25	58	12.81	63	10.81
45	2	13	23.62	29	18.50	48	16.06	53	10.69
50	2	15	24.75	36	17.56	58	14.75	62	10.56
55	2	13	26.50	33	19.12	54	15.25	56	9.37
60	2	21	23.81	42	18.50	60	14.37	61	8.81
65	2	18	22.37	33	18.06	48	14.87	53	9.69
70	3	14	23.87	31	17.56	52	16.12	54	10.44
75	2	13	26.25	34	18.37	51	14.69	-	8.50
80	2	20	24.68	41	18.50	54	14.75	56	9.31
85	3	18	22.50	43	18.31	62	12.56	64	8.87
90	3	14	22.75	34	17.06	55	15.81	59	12.56
95	2	14	27.81	30	18.37	49	11.62	50	9.37
100	3	15	24.75	36	17.00	56	12.06	57	9.44

* 1 represents globosa type, 2 represents intermediate type, 3 represents triangular type.

Table I. (Continued)

Plant No.	Plant Type	July 1		July 17		August 3		August 23	
		Height	Protein	Height	Protein	Height	Protein	Height	Protein
		ins.	percent	ins.	percent	ins.	percent	ins.	percent
105	3	18	21.43	37	12.75	51	9.31	52	7.75
110	3	21	22.93	45	16.37	65	12.81	68	7.06
115	3	25	23.25	56	19.31	79	12.75	81	9.25
120	2	20	23.50	43	19.00	58	14.69	59	11.81
125	3	19	23.19	42	20.43	59	16.12	62	9.44
130	3	19	22.87	38	18.00	60	13.37	67	10.94
135	1	11	24.87	24	19.56	41	16.12	45	12.25
140	1	18	21.62	32	19.62	42	13.44	43	8.69
145	3	13	21.87	29	12.06	42	12.19	45	12.50
150	2	12	22.93	26	18.44	45	13.56	47	10.25
155	1	15	27.25	36	18.37	46	12.69	46	8.69
160	3	14	22.31	33	13.44	44	11.44	45	10.44
165	1	23	21.81	43	17.50	58	13.50	60	9.56
170	2	14	22.87	31	14.06	40	11.62	40	8.68
175	3	17	23.19	36	18.75	55	13.75	55	7.12
180	1	23	23.56	44	18.00	56	13.87	57	8.37
185	3	13	26.00	35	18.75	58	15.00	59	10.00
190	3	17	24.37	39	19.19	61	13.12	62	7.44
195	3	12	22.06	30	19.31	49	13.00	51	8.56
200	3	18	24.19	36	13.19	51	10.12	51	6.75

Table I. (Continued)

Plant No.	Plant Type	July 1		July 17		August 3		August 23	
		Height	Protein	Height	Protein	Height	Protein	Height	Protein
		ins.	percent	ins.	percent	ins.	percent	ins.	percent
205	3	11	23.06	32	17.75	49	14.19	52	7.87
210	3	13	22.94	32	15.00	54	14.37	60	9.12
215	3	19	25.37	45	15.00	66	12.56	68	7.69
220	2	13	23.62	28	15.69	48	12.00	51	8.75
225	3	12	22.25	31	16.37	47	10.25	47	7.94
230	3	21	22.25	46	18.00	64	13.31	65	9.19
235	2	19	20.81	39	17.19	57	13.31	60	9.12
240	3	14	22.62	34	18.87	45	18.12	48	12.81
245	1	20	24.81	38	17.56	54	13.31	56	9.00
250	3	14	18.87	28	11.87	30	11.19	43	8.94
255	2	22	23.75	41	14.37	44	9.87	44	7.94
260	2	20	24.06	39	18.19	57	14.06	59	8.44
265	3	16	22.87	36	14.93	54	13.50	56	7.62
270	2	15	25.69	35	16.69	49	12.56	49	8.31
275	2	19	23.94	40	18.75	52	12.50	53	9.00
280	3	13	22.94	28	13.31	49	10.94	50	10.19
285	3	21	23.37	43	16.69	61	11.44	62	9.19
290	3	23	24.37	48	18.12	70	13.50	72	9.31
295	1	17	24.81	34	17.87	65	13.44	45	9.19
300	3	22	24.12	46	16.81	62	12.37	63	7.87

Table I. (Continued)

Plant No.	Plant Type	July 1		July 17		August 3		August 23	
		Height	Protein	Height	Protein	Height	Protein	Height	Protein
		ins.	percent	ins.	percent	ins.	percent	ins.	percent
305	3	19	23.75	44	16.19	57	10.37	60	10.56
310	2	12	22.81	29	18.12	55	11.12	55	10.25
315	3	24	24.56	48	14.75	62	10.44	63	9.12
320	3	20	24.56	45	17.12	60	11.62	60	8.19
325	3	25	23.50	49	16.87	63	13.19	63	7.87
330	2	21	24.50	42	15.06	57	10.19	59	10.00
335	3	23	21.00	44	17.19	57	12.06	58	9.31
340	2	21	21.69	39	13.25	46	10.62	46	9.06
345	3	20	22.81	42	17.69	65	16.69	69	9.94
350	3	13	24.62	33	21.06	55	12.81	58	10.00
355	2	15	25.50	32	19.50	48	16.69	49	11.81
360	3	17	24.31	35	14.75	49	11.12	49	9.87
365	2	16	23.62	34	19.37	54	13.06	58	12.37
370	3	12	25.44	31	18.87	52	13.75	55	9.37
375	3	13	23.94	31	20.50	52	14.19	55	10.37
380	2	17	25.00	39	16.81	61	12.87	61	10.44
385	3	15	24.06	36	13.37	48	10.06	50	9.19
390	1	15	24.50	36	18.06	51	10.94	53	8.81
395	3	12	25.25	30	17.94	54	13.00	62	11.31
400	1	19	22.50	36	13.50	47	10.87	48	7.44

Table I. (Continued)

Plant No.	Plant Type	July 1		July 17		August 3		August 23	
		Height	Protein	Height	Protein	Height	Protein	Height	Protein
		ins.	percent	ins.	percent	ins.	percent	ins.	percent
405	3	18	23.75	39	19.12	52	10.81	64	8.44
410	3	20	21.81	43	15.56	61	11.56	64	7.62
415	3	21	23.75	46	18.87	65	15.44	66	9.81
420	3	19	24.44	47	16.69	61	12.69	63	8.56
425	1	16	24.94	35	18.50	47	15.94	48	11.19
430	3	23	24.31	48	15.50	70	12.12	73	7.62
435	2	13	24.25	33	17.56	50	12.75	50	8.44
440	2	14	24.31	31	13.12	44	11.25	45	8.50
445	3	10	24.25	25	16.00	45	12.62	49	8.62
450	3	13	-	36	18.06	55	10.87	57	8.12
455	3	19	22.25	42	16.00	57	11.31	57	8.37
460	3	15	25.31	39	18.00	61	13.12	64	9.00
465	3	16	24.06	41	19.87	67	13.69	69	8.94
470	3	14	25.69	38	19.69	57	13.56	58	11.69
475	3	18	24.62	41	19.69	60	14.19	61	9.69
480	3	18	25.12	45	19.69	68	13.75	70	9.56
485	1	15	23.50	33	17.75	54	15.62	55	9.62
490	3	14	22.44	33	16.00	48	10.87	50	9.12
495	3	18	23.00	41	18.00	66	12.00	68	9.00
500	3	15	21.56	36	19.37	58	14.19	61	7.44

Table I. (Continued)

Plant No.	Plant Type	July 1		July 17		August 3		August 23	
		Height	Protein	Height	Protein	Height	Protein	Height	Protein
		ins.	percent	ins.	percent	ins.	percent	ins.	percent
505	3	19	22.87	40	16.87	62	12.81	63	8.87
510	3	18	22.81	42	17.50	61	12.25	66	8.94
515	3	17	25.06	37	17.12	56	12.00	57	10.06
520	3	14	21.12	31	13.81	39	11.69	40	12.44
525	2	14	23.94	30	15.69	42	11.12	43	9.12
530	1	15	21.37	31	20.43	46	14.56	49	10.00