THE PERFORMANCE OF CERTAIN SUMMER ANNUAL CROPS AS MEASURED BY YIELD AND CERTAIN CHEMICAL COMPONENTS

by

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IV. INTRODUCTION

The lack of summer rainfall that has prevailed in Virginia during the past several growing seasons has caused farmers of the state to show an increasing amount of interest in crops that are said to require less moisture than those normally grown for forage.

This problem was set up to try to find crops and mixtures that could be planted in the late spring or early summer, after the growing season has progressed enough for the farmer to predict his production and also his forage needs, to supplement his regular forage plan. These crops need to be versatile in that they may be used for hay, grazed, or used for silage as the need may be.

If farmers in the late spring or early summer are overstocked with livestock in relation to prospective feed supply, it might be possible, through the use of supplemental crops, to carry the livestock on hand to a more desirable selling date instead of selling when the prices are less favorable.

On certain farms summer annual plants are also needed that can be seeded and grown without plowing and cultivating. It would, of course, be necessary to disc the soil thoroughly before seeding. These annual plants or mixtures could be grown on land too steep for cultivated crops such as corn, but would still produce a high yield of forage per acre.

Supplemental crops might also be used in situations where farmers planned to seed permanent hay or pasture crops in the spring, but moisture conditions were not suitable at the optimum seeding date. Farmers

could seed sudangrass or millet, or even a mixture of the two to get a crop off the land during the summer and still prepare the soil for fall seeding of hay or pasture crops.

The experiment reported herein was conducted to measure the productive capacity of some of the summer annual plants when grown alone and in mixtures. Data were also obtained on the aggressiveness of different species when grown alone and in mixtures. Chemical analyses were made for certain elements.

V. REVIEW OF LITERATURE

Workers in Pennsylvania, reporting data for one year only, found the total dry matter production of sweet commercial sudangrass to be approximately three and one-half tons per acre with nine percent protein (2). Pearl millet in the same experiment yielded four and one-half tons of dry matter per acre with a protein content of nine percent. The protein content of pearl millet was slightly lower than that of some other varieties of millet; however, it was higher in total production of protein per acre because of its greater yielding ability.

In an experiment when soybeans and sudangrass were sown together at the rate of 60 pounds of soybeans and 10 pounds of sudangrass per acre, the hay yield for a four-year average was three tons per acre (7). The protein production was 663 pounds per acre. Sudangrass alone also produced three tons of hay but only 321 pounds of protein per acre.

In another experiment, sudangrass produced three tons of hay as compared to seven and eight-tenths tons from amber sorghum.

Wood and Burleson (11) reported that Hegari sorghum yielded 18 tons of green material and six and one-third tons of air-dry material per acre. In the same experiment pearl millet also yielded 18 tons of green material per acre but only four and two-thirds tons of dry material. They also reported seven and one-half tons of green material and one and six-tenths tons of dry material per acre from sweet sudangrass.

Holt and Vaura (3) reported that cowpeas, planted in the row with sudangrass, appeared to have no influence on the total yield of forage. However, cowpeas planted in the row with sudangrass did significantly

increase the average content of crude protein of the first cutting.

Wiggans (9) found that the percentage of total dry matter in corn grown with soybeans was not significantly changed, but the percentage of dry shelled grain in the total dry matter was significantly reduced. The percentage of total dry matter in soybeans grown with corn as compared to the percentage when grown alone depended on the season, and very probably on other factors such as available moisture, nitrogen, phosphorus, and other mineral elements.

Three two-year rotations in which sudangrass, soybeans, and oats were alternated with corn were compared between 1919 and 1933 inclusive by Wilkins and Hughes (10). The experiment was conducted on a fertile black soil (O'Neill), which was well supplied with minerals. All crops were removed except corn stalks and some fallen soybean leaves. Corn grown after sudangrass gave a yield of 50.8 bushels per acre as compared with 49.0 bushels after soybeans, and 47.8 bushels following oats. These differences were not statistically significant. The results were not changed by applying superphosphate at corn planting time to half of each plot in the later years. Sudangrass removed over twice as much dry matter as soybeans or oats, over twice as much nitrogen as oats, and considerably more nitrogen than soybeans. Despite these heavy withdrawals, the sudangrass plots appeared to be just as productive after 13 years of cropping as the soybean and oat plots. Fall plowing of sudangrass stubble increased the yield of corn 10.7 percent over spring plowing.

Because of their superior drought resistance, grain sorghums

largely replace corn in the Southwest where average annual precipitation is less than 25 inches (5). Sorghum leaves have more stomata per unit of area, but stomata are smaller than those on corn leaves. Sorghum leaves and stems have a waxy cutinized epidermis which reduces evaporation. Sorghum plants are less leafy than corn plants, but have more secondary roots than does corn. Sorghum stalks have a lower moisture content than corn stalks and they also have a lower transpiration ratio than corn under conditions of high evaporation.

Sorghum leaves and stalks wilt and dry more slowly than those of corn. The slower drying permits sorghum plants to withstand drought longer than corn and they may subsequently recover when moisture becomes available. The waxy cuticle apparently is largely responsible for the slow drying of sorghums. It is believed that the sorghum stalk recovers from a period of dormancy induced by drought because it has not wilted beyond recovery. It is also possible for sorghum plants to develop tillers and still produce a crop if rain comes after the main stalks have been killed by drought.

Workers in Mississippi found when they used 150 pounds of nitrogen per acre that the yield of sorghum was 20.67 tons as contrasted to 11.97 tons per acre of corn (8). The corn silage had a higher protein content than did the sorghum silage; however, because of the higher yield, sorghum produced more pounds of total digestible nutrients per acre, exceeding corn by 1600 pounds. In this same test, Sart Sargo, a late maturing variety of sorghum, was compared to the Dixie 22, 18, and 33 varieties of hybrid corn.

In an experiment in Virginia [4], corn and other silage crops were compared. Data from the experiment are given in the following table:

Crop	Variety	Tons Green Material Per Acre	4-yr. Av. Yield Lbs. D.M. Acre
Corn	Cocke's Prolific	16.04	6962
Corn	Boone County White	13.66	6830
Sorghum	Early Amber	12.12	5398
Soybeans	Mammoth Yellow	10.15	5239
Cowpeas	Whippoorwill	8.36	3123
Millet	Golden (German)	5.63	3982

Workers in Illinois found that soybeans yielded two and one-half tons of dry matter per acre if harvested when the plants contained 33 percent dry matter as compared to three tons of dry matter per acre of corn [6]. To make a silage that was rated "good", it was necessary to let the soybeans reach a dry matter content of 30 to 35 percent and add five percent cane molasses and eight percent water to the material when it was put into the silo. The sudangrass and soybean mixture yielded two and three-tenths to four and four-tenths tons of dry matter per acre. This mixture made an inferior silage as compared to corn silage. These workers also found that sorghums required on the average of ten days longer to reach the same dry matter level as adapted corn hybrids.

VI. PROCEDURE

The objectives of this study were set up to (1) determine the total yield of the crops and mixtures included in this experiment, (2) measure aftermath production of those crops in the mixture that produce aftermath growth, (3) determine the individual plant size of the different species when grown alone and in mixtures, and (4) determine by chemical analysis the nitrogen, calcium, phosphorus, potassium, and magnesium content of the various mixtures.

The crops and varieties tested in this experiment were as follows:

Crop	Scientific Name	Variety
Sweet Sorghum	*Sorghum vulgare*	Early Amber
Soybeans	*Glycine max*	Wilson
Pearl Millet	*Pennisetum glaucum*	Commercial
Sudangrass	*Sorghum sudanensis*	Sweet
Grain Sorghum	*Sorghum vulgare*	Hegari
Corn	*Zea mays*	U.S. 262
Velvet Beans	*Stizolobium deeringianum*	Commercial

The crops were grown alone and in mixtures except for grain sorghum which was grown by itself, and velvet beans which were grown only with corn.

The following is a list of crops, mixtures, seeding rates, and seeding methods:

Crop or Mixture No.	Crops and Mixtures	Seeding Rate Lbs. per Acre	Seeding Method
1	Sweet Sorghum	10	Drilled in Row
2	Soybeans	60	Broadcast

Crop or Mixture No.	Crops and Mixtures	Seeding Rate Lbs. per Acre	Seeding Method
3	Millet	40	Broadcast
4	Sudangrass	40	Broadcast
5	Grain Sorghum	8	Drilled in Row
6	Corn	10	Drilled in Row
7	Soybeans Sweet Sorghum	60 10	Broadcast
8	Corn Sweet Sorghum	5 8	Drilled in Row
9	Soybeans Millet	60 20	Broadcast
10	Soybeans Sudangrass	60 20	Broadcast
11	Corn Soybeans	5 40	Drilled in Row
12	Corn Soybeans Millet Sweet Sorghum	5 40 20 6	Broadcast
13	Corn Velvet Beans	5 5	Drilled in Row
14	Corn Soybeans Sudangrass Sweet Sorghum	5 40 20 6	Broadcast

A Groseclose silt loam was prepared during the early part of May and fertilized with 600 pounds of 10-10-10 fertilizer plus 200 pounds of 33 percent ammonium nitrate per acre. The fertilizer was applied uniformly over the entire plot area and disked into the soil. The test was planted May 25, 1954 at Blacksburg, Virginia on the Kipps farm which is leased by the Agronomy Department of the Virginia Polytechnic

Institute. The statistical design of the experiment was a randomized block replicated four times. The plots were 12 feet wide and 30 feet long. A harvest strip 64 inches wide was taken lengthwise through the center of the broadcast plots and the two center rows, or 72 inches were harvested from the row seedings.

Green weights were taken in the field immediately after cutting. The entire harvest strip was chopped by a forage harvester and a sub-sample weighing three to four pounds was taken after the sample had been thoroughly mixed. The sub-samples were weighed before and after drying for moisture determinations. The dried samples were ground coarsely with a Wiley mill and sub-samples of about 225 grams were taken and ground very finely for chemical analyses. Determinations were made for nitrogen, calcium, phosphorus, potassium, and magneisum content of each mixture by a laboratory technician in the Agronomy Department.

At harvest time, the height of each crop in each mixture was recorded. Twenty plants of each crop were taken from each plot and dried in the forage drier and then weighed. The weights per plant were calculated for each crop in each mixture.

The crops grown alone were harvested when the seed heads were in the soft dough stage. The crops grown in the mixtures were harvested when the seed heads of the predominant crop in the mixture was in the soft dough stage.

The weights reported throughout this report refer to oven dry weight of the material.

The reference to "difference" as used in this report indicates that the differences are statistically significant. The analysis of

variance and field data are given in the appendix.

The technique of grouping for significance as used in this report was formulated by Dr. D. B. Duncan (1), formerly of the Statistics Department of the Virginia Polytechnic Institute.

VII. RESULTS AND DISCUSSION

Rainfall:

The rainfall at Blacksburg for the months of May, June, July, August and September during the period of 1940-1954 has averaged 19.54 inches. The total rainfall for these five months in 1954 was 13.99 inches, a total of 5.55 inches less than the 1940-1954 average.

Distribution is more important than total rainfall. During the month of June, 1954 the total rainfall was 1.48 inches as compared with an average of 4.50 inches for the same period in 1940-1954. July, 1954 had a total of 3.98 inches as compared to 4.39 inches for the same period in 1940-1950; however, 2.60 inches of the July, 1954 total fell during a period of 48 hours, thus much of this rainfall was lost in runoff.

The distribution of rainfall for the 1954 growing season was very erratic as is shown in Figure 1.

Yields:

Although corn requires a large amount of water, the mixture of corn and soybeans (planted in the row) produced a higher yield, 7750 pounds per acre, of forage than any of the other crops tested as is shown in Table 1. Corn alone ranked second in yield, although it was not significantly different from the mixtures of sweet sorghum, millet, grain sorhum, corn-sweet sorghum, corn-soybeans-millet-sweet sorghum, corn-velvet beans, and corn-soybeans-sudan grass-sweet sorghum.

Soybeans grown alone produced 3243 pounds of forage per acre, the lowest yielding crop or mixture in the experiment.

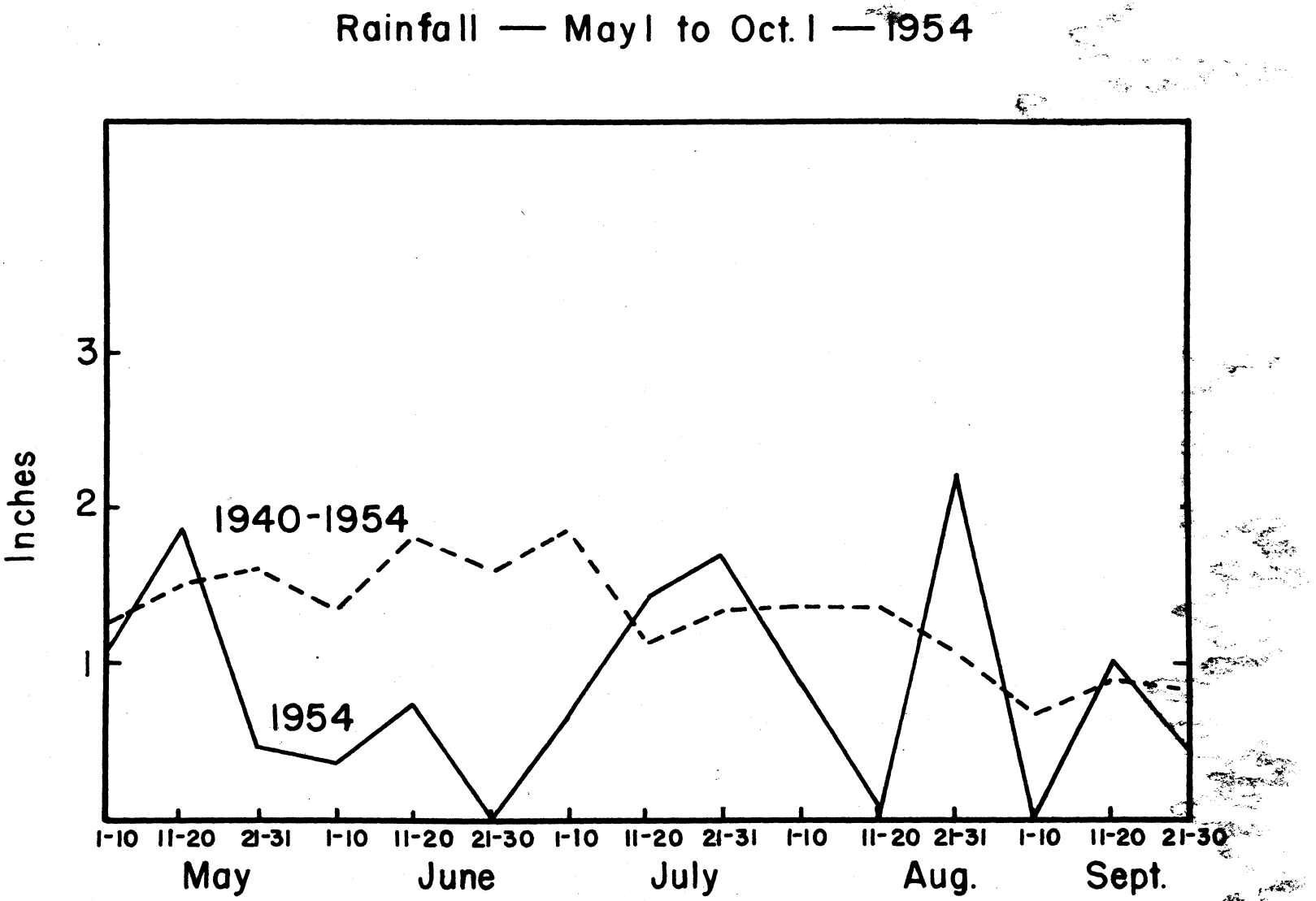

Figure 1. Rainfall at Blacksburg, Virginia, May 1 - October 1, 1954 as compared to the 1940-1954 average in accumulated totals for 10 day intervals.

TABLE 1

CROP AND MIXTURE YIELDS PER ACRE

Crop or Mixture No.	Crop or Mixture	Method of Planting	Yields in Pounds Dry Matter Per Acre: First Cutting	Second Cutting	Total
1	Sweet Sorghum	Row	5433		5433
2	Soybeans	Row	3243		3243
3	Millet	Broadcast	4592	498	5090
4	Sudangrass	Broadcast	3170	1456	4507
5	Grain Sorghum	Row	5161		5161
6	Corn	Row	6268		6268
7	Soybeans, Sweet Sorghum	Broadcast	4725		4725
8	Corn, Sweet Sorghum	Row	6238		6238
9	Soybeans, Millet	Broadcast	3987	644	4631
10	Soybeans, Sudangrass	Broadcast	3436	767	4204
11	Corn, Soybeans	Row	7750		7750
12	Corn, Soybeans, Millet Sweet Sorghum	Broadcast	4592	755	5322
13	Corn, Velvet Beans	Row	5996		5996
14	Corn, Soybeans Sudangrass, Sweet Sorghum	Broadcast	4610	946	5446

Significant Groups for Pounds of Dry Matter Per Acre for First Cutting

4	2	10	9	12	3	14	7	5	1	13	8	6	11
3170	3243	3436	3987	4592	4592	4610	4725	5161	5433	5996	6238	6268	7750

Significant Groups for Pounds Dry Matter Per Acre for Second Cutting

3	9	12	10	14	4
498	644	755	767	946	1456

Significant Groups for Pounds Dry Matter Per Acre for Combined First and Second Cuttings

2	10	4	9	7	3	5	12	1	14	13	8	6	11
3243	4204	4507	4631	4725	5090	5161	5322	5433	5446	5996	6238	6268	7750

(Table 1 continued)

Analysis of Variance for First Cutting

Pounds Dry Matter per Plot

Source of Variance	df	MS	F
Treatment	13	117.309	13.372**
Replicates	3	8.633	0.984
Error	39	8.773	
Total	55		

Analysis of Variance for Second Cutting

Pounds Dry Matter per Acre

Source of Variance	df	MS	F
Treatment	5	2,386,801	68.4**
Replicates	3	29,545	N.S.
Error	15	34,901	
Total	23		

Analysis of Variance for Total Yield

Pounds Dry Matter per Plot

Source of Variance	df	MS	F
Treatment	13	80.094	8.096**
Replicates	3	9.937	1.004
Error	39	9.893	
Total	55		

Millet was in the second grouping for significance, producing 5090 pounds of dry matter per acre as compared to sudangrass which produced only 4507 pounds per acre and placed in the third group for significance. The sudangrass was severely affected by a leaf blight disease which lowered considerably the quality and most likely the yield of forage.

Sweet sorghum produced 5433 pounds of forage per acre as compared to 5161 pounds for grain sorghum. There was no significant difference in the production of forage by sweet sorghum and grain sorghum. The mixture of sweet sorghum and soybeans produced 4725 pounds of dry matter per acre. This production was significantly higher than soybeans alone and lower than sweet sorghum alone. The sweet sorghum grown alone and sweet sorghum grown with corn was not significantly different in total yield. The mixtures of soybeans-millet and soybeans-sudangrass were not different in total yield, producing 4631 and 4204 pounds of dry matter per acre respectively. The complex mixtures of corn-soybeans-millet-sweet sorghum and corn-soybeans-sudangrass-sweet sorghum produced 4592 and 4610 pounds per acre respectively. These mixtures ranked seventh and fifth respectively in total production.

The mixture of corn and velvet beans should be considered as corn alone since the germination of the beans was so poor that there were not enough velvet beans in the mixture to influence the yield of the mixture.

Chemical Composition of the Crops or Mixtures:

The crop containing the highest percent protein was soybeans grown

alone, with a protein content of 15 percent (Table 2). Sweet sorghum grown alone contained 10.3 percent protein; however, the mixture of soybeans and sweet sorghum contained only 9.7 percent of protein, which was much less than for soybeans grown alone.

Even though millet was more aggressive in the mixtures than was sudangrass, the mixture containing corn-soybeans-millet-sweet sorghum had a higher percent protein than did the mixture containing corn-soybeans-sudangrass-sweet sorghum. Sudangrass also had a higher percent protein than did millet when both were grown alone.

Soybeans grown with corn did not significantly raise the percentage of protein above that of corn grown alone; the corn-soybeans mixture contained 11.9 percent as compared to 11.5 percent for corn grown alone. However, both these mixtures were higher in protein than was the mixture of corn-velvet beans. Corn grown with sweet sorghum was significantly lower in percent protein than was corn grown alone.

Grain sorghum contained 11.0 percent protein as compared to 10.3 percent for sweet sorghum. Grain sorghum was also higher in protein than was the soybean-sweet sorghum mixture, but there was no difference in protein content of the grain sorghum and the corn-soybean mixture.

There was no significant difference in the phosphorus, potassium, calcium, and magnesium content of the crops and mixtures as shown in Table 3.

Protein Production Per Acre:

The corn-soybean mixture gave the greatest production of protein per acre with a total of 911 pounds (Table 2). This amount was

TABLE 2

PERCENT PROTEIN AND POUNDS PROTEIN PER ACRE

Crop or Mixture No.	Crop or Mixture	Method of Planting	Percent Protein	Pounds Protein Per Acre
1	Sweet Sorghum	Row	10.3	557
2	Soybeans	Row	15.0	490
3	Millet	Broadcast	10.8	549
4	Sudangrass	Broadcast	12.9	582
5	Grain Sorghum	Row	11.0	573
6	Corn	Row	11.5	728
7	Soybeans, Sweet Sorghum	Broadcast	9.7	458
8	Corn, Sweet Sorghum	Row	10.5	653
9	Soybeans, Millet	Broadcast	13.3	616
10	Soybeans, Sudangrass	Broadcast	11.3	473
11	Corn, Soybeans	Row	11.9	911
12	Corn, Soybeans, Millet, Sweet Sorghum	Broadcast	13.1	702
13	Corn, Velvet Beans	Row	10.4	625
14	Corn, Soybeans, Sudangrass Sweet Sorghum	Broadcast	12.0	660

Significant Groups for Pounds Protein Per Acre

7	10	2	3	1	5	4	9	13	8	14	12	6	11
458	473	490	549	557	573	582	616	625	653	660	702	728	911

Analysis of Variance for Pounds Protein Per Acre

Source of Variance	df	MS	F
Treatments	13	0.025	3.57**
Replicates	3	0.003	0.43
Error	39	0.007	
Total	55		

TABLE 3

PERCENTAGE CHEMICAL COMPOSITION

Crop or Mixture No.	Crop or Mixture	P	K	Ca	Mg
1	Sweet Sorghum	0.195	1.798	0.558	0.403
2	Soybeans	0.188	1.813	0.655	0.373
3	Millet	0.173	1.612	0.500	0.333
4	Sudangrass	0.183	1.598	0.625	0.553
5	Grain Sorghum	0.165	1.565	0.525	0.343
6	Corn	0.170	1.638	0.501	0.335
7	Soybeans, Sweet Sorghum	0.155	1.397	0.608	0.433
8	Corn, Sweet Sorghum	0.163	1.388	0.543	0.353
9	Soybeans, Millet	0.165	1.615	0.538	0.380
10	Soybeans, Sudangrass	0.160	1.432	0.650	0.390
11	Corn, Soybeans	0.170	1.520	0.780	0.398
12	Corn, Soybeans, Millet, Sweet Sorghum	0.178	1.600	0.473	0.290
13	Corn, Velvet Beans	0.168	1.288	0.643	0.390
14	Corn, Soybeans, Sudangrass Sweet Sorghum	0.168	1.350	0.575	0.383

Analysis of Variance
for Certain Chemical Components of Samples

Source of Variance	df	Phosphorus MS	Phosphorus F	Potassium MS	Potassium F
Treatments	13	0.00054	0.853 N.S.	0.099	0.702 N.S.
Replicates	3	0.00033	0.541	0.130	0.921
Error	39	0.00061		0.141	
Total	55				

Source of Variance	df	Calcium MS	Calcium F	Magnesium MS	Magnesium F
Treatments	13	0.027	1.5 N.S.	0.016	1.60 N.S.
Replicates	3	0.003	0.166	0.006	0.60
Error	39	0.018		0.010	
Total	55				

significantly higher than corn alone which produced 728 pounds of protein per acre. Although soybeans grown alone had the highest percentage of protein of all the mixtures, the total production of protein was only 473 pounds per acre due to its low total yield which was slightly more than half the production from the corn-soybean mixture.

There was no significant difference in protein production per acre for the following crops or mixtures: corn, corn-soybeans-millet-sweet sorghum, corn-soybeans-sudangrass-sweet sorghum, corn-sweet sorghum, corn-velvet beans, soybeans-millet, sudangrass, grain sorghum, sweet sorghum, and millet.

It is interesting to note that with the exception of soybeans, there was no difference in protein production per acre in any of the crops tested in the experiment when they were grown alone.

Species Competition:

Competition among and within species was studied by comparing plant heights and weights of a given species when grown in pure stands and in mixtures. The average plant weights of sweet sorghum grown alone and in mixtures for 20 plant samples taken from each four replicated plots are shown in Table 4. The individual plant weight for sweet sorghum grown alone and in the row averaged 56.2 grams per plant as compared to 17.7 grams when sweet sorghum was grown with corn in the row. This shows that corn retarded the growth of the sweet sorghum plants when they were grown together in the row.

When sweet sorghum was broadcast with soybeans, the weight per plant was not significantly reduced from that of the sweet sorghum grown alone

TABLE 4

SWEET SORGHUM WEIGHTS IN GRAMS PER PLANT

WHEN GROWN ALONE AND IN MIXTURES

Crop or Mixture No.	Crop or Mixture	Method of Planting	Average Wt. Per Plant
1	Sweet Sorghum	Row	56.2
7	Soybeans, Sweet Sorghum	Broadcast	49.7
8	Corn, Sweet Sorghum	Row	17.7
12	Corn, Soybeans, Millet Sweet Sorghum	Broadcast	12.8
14	Corn, Soybeans, Sudangrass Sweet Sorghum	Broadcast	16.9

Significant Groups for Weight Per Plant

12	14	8	7	1
12.8	16.9	17.7	49.7	56.2

Analysis of Variance

Source of Variance	df	MS	F
Treatments	4	1,693.30	37.92**
Replicates	3	116.87	2.62
Error	12	44.65	
Total	19		

and in rows. The mixture of corn-soybeans-millet-sweet sorghum very drastically reduced the weight per plant of sweet sorghum as did the mixture containing corn-soybeans-sudangrass-sweet sorghum.

The height per plant for sweet sorghum was determined by taking a measurement of each of the four replicated plots and is given in Table 5. The sweet sorghum planted alone and in the row was taller than the sweet sorghum in any of the mixtures. It made no difference whether the mixture was broadcast or planted in the row.

Table 6 gives the weights per plant for soybeans when grown alone and in mixtures. The individual plant weights for soybeans grown alone was 24.9 grams as compared to 8.9 grams when grown in the row with corn. This shows that corn retarded the growth of soybean plants in row plantings.

Soybeans broadcast with sweet sorghum had a weight per plant of 16.2 grams; when grown with millet sweet sorghum weighed 2.3 grams per plant, and when grown with sudangrass it had a weight of 2.8 grams per plant. This shows that both sudangrass and millet were more aggressive to soybeans than was sweet sorghum. The weight per plant for soybeans when grown in corn-soybeans-millet-sweet sorghum mixture was 2.3 grams as compared with 2.4 grams when grown in a mixture of corn-soybeans-sudangrass-sweet sorghum.

The height of the soybean plants due to competition from other crops was affected very much like the weight (Table 7). The soybeans planted alone were significantly taller than those in mixture containing corn, millet, or sudangrass.

TABLE 5

SWEET SORGHUM HEIGHTS IN INCHES

WHEN GROWN ALONE AND IN MIXTURES

Crop or Mixture No.	Crop or Mixture	Method of Planting	Average Ht. Per Plant
1	Sweet Sorghum	Row	69.0
7	Soybeans, Sweet Sorghum	Broadcast	53.0
8	Corn, Sweet Sorghum	Row	48.8
12	Corn, Soybeans, Millet Sweet Sorghum	Broadcast	41.8
14	Corn, Soybeans, Sudangrass Sweet Sorghum	Broadcast	48.8

Significant Groups for Height Per Plant

12	14	8	7	1
41.8	48.8	48.8	53.0	69.0

Analysis of Variance

Source of Variance	df	MS	F
Treatments	4	415.88	22.71**
Replicates	3	34.18	1.87
Error	12	18.31	
Total	19		

TABLE 6

SOYBEAN WEIGHTS IN GRAMS PER PLANT

WHEN GROWN ALONE AND IN MIXTURES

Crop or Mixture No.	Crop or Mixture	Method of Planting	Average Wt. Per Plant
2	Soybeans	Row	24.9
7	Soybeans, Sweet Sorghum	Broadcast	16.2
9	Soybeans, Millet	Broadcast	2.3
10	Soybeans, Sudangrass	Broadcast	2.8
11	Corn, Soybeans	Row	8.9
12	Corn, Soybeans, Millet Sweet Sorghum	Broadcast	2.3
14	Corn, Soybeans, Sudangrass, Sweet Sorghum	Broadcast	2.4

Significant Groups for Weight Per Plant

9	12	14	10	11	7	2
2.3	2.3	2.4	2.9	8.9	16.2	24.9

Analysis of Variance

Source of Variance	df	MS	F
Treatments	6	315.80	95.12**
Replicates	3	4.22	1.27
Error	18	3.32	
Total	27		

TABLE 7

SOYBEAN HEIGHTS IN INCHES

WHEN GROWN ALONE AND IN MIXTURES

Crop or Mixture No.	Crop or Mixture	Method of Planting	Average Ht. Per Plant
2	Soybeans	Row	40.5
7	Soybeans, Sweet Sorghum	Broadcast	37.0
9	Soybeans, Millet	Broadcast	26.0
10	Soybeans, Sudangrass	Broadcast	27.3
11	Corn, Soybeans	Row	33.5
12	Corn, Soybeans, Millet Sweet Sorghum	Broadcast	25.8
14	Corn, Soybeans, Sudangrass Sweet Sorghum	Broadcast	29.3

Significant Groups for Height Per Plant

12	9	10	14	11	7	2
25.8	26.0	27.3	29.3	33.5	37.0	40.5

Analysis of Variance

Source of Variance	df	MS	F
Treatments	6	134.31	12.69**
Replicates	3	11.94	1.13
Error	18	10.58	
Total	27		

Table 8 gives the average height and weight per plant for millet when grown alone and in mixtures. Millet grown alone had the lowest weight per plant, 3.1 grams as compared to 11.3 grams when grown in the mixture of corn-soybeans-millet-sweet sorghum. When grown with soybeans, millet had a weight per plant of 5.8 grams, not significantly different from the weight per plant when grown alone. This indicates that millet is highly competitive with itself and is very aggressive when seeded with other plants.

There was no significant difference in the height of the millet plants when grown in pure stands and when grown in mixtures.

The behavior of sudangrass (Table 9) was much like that of millet. The sudangrass had a much higher weight per plant when grown in a mixture of corn-soybeans-sudangrass-sweet sorghum than when grown alone or with soybeans. This indicates that sudangrass, like millet, is very competitive with itself and is very aggressive toward other plants when grown in a mixture.

There was no difference in the height of the sudangrass plants (Table 9) when grown alone and in mixtures.

Table 10 gives the weight per plant for corn when grown alone and in mixtures. In row plantings, the weight per corn plant was about the same for pure stands as for mixed seedings. This indicates that the competition among individual corn plants, for such factors as moisture, nutrients, and light, was no greater than the competition among corn and other species in row plantings. However, when corn was broadcast, the weight per plant was drastically reduced below that of any row treatment.

TABLE 8

MILLET WEIGHTS IN GRAMS AND HEIGHTS IN INCHES PER PLANT

WHEN GROWN ALONE AND IN MIXTURES

Crop or Mixture No.	Crop of Mixture	Method of Planting	Average Wt. Per Plant	Average Ht. Per Plant
3	Millet	Broadcast	3.1	36.8
9	Soybeans, Millet	Broadcast	5.8	38.8
12	Corn, Soybeans, Millet Sweet Sorghum	Broadcast	11.3	41.5

Significant Groups for Weight Per Plant

3	9	12
3.13	5.83	11.3

Analysis of Variance

Source of Variance	df	Plant Weights MS	Plant Weights F	Plant Heights MS	Plant Heights F
Treatments	2	68.50	18.17**	22.75	.78 N.S.
Replicates	3	2.14	.57	7.56	.26
Error	6	3.77		29.30	
Total	11				

TABLE 9

SUDAN WEIGHTS IN GRAMS AND HEIGHTS IN INCHES PER PLANT

WHEN GROWN ALONE AND IN MIXTURES

Crop or Mixture No.	Crop or Mixture	Method of Planting	Average Wt. Per Plant	Average Ht. Per Plant
4	Sudan Grass	Broadcast	1.9	47.0
10	Soybeans, Sudangrass	Broadcast	2.6	49.5
14	Corn, Soybeans, Sudangrass, Sweet Sorghum	Broadcast	3.9	51.3

Significant Groups for Weight Per Plant

4	10	14
1.9	2.6	3.9

Analysis of Variance

		Plant Weights		Plant Heights	
Source of Variance	df	MS	F	MS	F
Treatments	2	4.23	12.44**	18.25	.82 N.S.
Replicates	3	.18	.53	12.75	.57
Error	6	.34		22.25	
Total	11				

TABLE 10

CORN WEIGHTS IN GRAMS PER PLANT

WHEN GROWN ALONE AND IN MIXTURES

Crop or Mixture No	Crop of Mixture	Method of Planting	Average Wt. Per Plant
6	Corn	Row	98.3
8	Corn, Sweet Sorghum	Row	80.0
11	Corn, Soybeans	Row	100.3
12	Corn, Soybeans, Millet Sweet Sorghum	Broadcast	18.5
13	Corn, Velvet Beans*	Row	100.3
14	Corn, Soybeans, Sudangrass Sweet Sorghum	Broadcast	20.6

Significant Groups for Weight Per Plant

12	14	8	6	11	13
18.5	20.6	80.0	98.3	100.3	100.3

Analysis of Variance

Source of Variance	df	MS	F
Treatments	5	6,241.41	27.87**
Replicates	3	103.44	.46
Error	15	223.94	
Total	23		

*Velvet beans did not grow.

The weight per plant of corn in the corn-soybean-millet-sweet sorghum mixture was 18.5 grams as compared to 100.3 grams when grown with soybeans in the row.

Corn grown alone in the row was 72.5 inches tall (Table 11) as compared to 35.8 inches when grown in a broadcast mixture of corn-soybeans-sudangrass-sweet sorghum. In row plantings, the height of corn was similar for pure stands and mixtures, but the height of corn plants were drastically reduced in all mixed broadcast seedings.

TABLE 11

HEIGHT OF CORN PLANTS IN INCHES

WHEN GROWN ALONE AND IN MIXTURES

Crop or Mixture No.	Crop or Mixture	Method of Planting	Average Ht. Per Plant
6	Corn	Row	72.5
8	Corn, Sweet Sorghum	Row	68.5
11	Corn, Soybeans	Row	76.3
12	Corn, Soybeans, Millet Sweet Sorghum	Broadcast	35.0
13	Corn, Velvet Beans*	Row	76.3
14	Corn, Soybeans, Sudangrass Sweet Sorghum	Broadcast	34.8

Significant Groups for Height Per Plant

14	12	8	6	11	13
34.8	35.0	68.5	72.5	76.3	34.8

Analysis of Variance

Source of Variance	df	MS	F
Treatments	5	1,613.94	35.91**
Replicates	3	8.04	.18
Error	15	44.94	
Total	23		

*Velvet Beans did not grow.

VIII. GENERAL DISCUSSION AND CONCLUSIONS

On many farms, the cattle stocking intensity is limited by the winter feed supply. The use of high yielding summer annual forage crops is a method of providing for more winter feed.

Corn grown alone or in simple mixtures in row plantings generally gave the highest forage yield. However, this does not mean that corn should be universally used in preference to all other crops. The broadcasting of pure or mixed seedings of summer annual crops has a place on farms where the topography does not permit row plantings. On such farms good yields can be expected from broadcast seedings of millet, sudangrass or mixtures of the two. On farms where row-crop or tillable land is limited, a double cropping system would increase the acre yields. With a double cropping system, winter annuals (small grain crops) could be harvested for silage in the spring. Immediately after harvesting the small grain, the same land area could be planted to summer annual crops and could be used for silage or grazing. It would be possible to use sudangrass or millet since these crops mature in a short growing season. An early corn hybrid that matures in a short season might also be used. In addition to controlling erosion on steep land, the double cropping system would also offer some protection from an acute summer drought.

Grain sorghum and sweet sorghum produced about the same yield per acre. The difference was not statistically significant. Compared to the other species tested, the sorghums were about average in forage production.

There was no mixture other than corn and soybeans that was outstanding in total production.

Soybeans were not at all competitive in any of the mixtures and produced a very low yield when seeded alone. This experiment did not show that soybeans raised the percentage of protein in any mixture except that of soybean-millet. The data from this experiment indicate that soybeans should not be seeded in mixtures because of their very poor competition and slow seedling development. They also present a maturity problem in that both sudangrass and millet mature much sooner than the soybeans and this in turn presents a seeding problem in that if the crops are grown together and if they are to be harvested at the optimum growth stage for both plants, then the soybeans must be planted quite some time ahead of the millet and sudangrass.

Additional research work needs to be done on the seedling competition of the summer annuals tested in this experiment. Data are needed on the optimum seeding rate when these crops are grown together. Information is lacking on planting depth and seeding date when planting a mixture of several species.

The author used the best information available concerning the above factors in conducting this experiment; however, it must be admitted that mixture composition and seeding rate used in the experiment reported herein may not give optimum yields. In subsequent experiments, basic information on species behavior in various mixtures should help compound better mixtures.

IX. SUMMARY

This experiment was conducted to obtain information on certain summer annual plants grown alone and in mixtures. In some cases the species and mixtures were planted in the row and in other cases broadcast.

The species and mixtures that were included in this experiment were as follows: sweet sorghum, soybeans, pearl millet, sudangrass, grain sorghum, corn, and velvet beans. These crops were planted alone and in various combinations with the exception of velvet beans and grain sorghum. Velvet beans were only planted with corn, and the grain sorghum was planted alone.

Although the growing season at Blacksburg during the summer of 1954 was very unfavorable, the corn and corn mixtures produced the greatest amount of forage when planted in the row and cultivated. Results indicate that it is not practical to broadcast corn mixtures with other crops. Data show that both the height and weight per plant were very drastically reduced when corn was used in broadcast seedings.

Forage production by sweet sorghum and grain sorghum was similar. Sweet sorghum gave a yield of 5,433 pounds of dry matter per acre whereas grain sorghum produced 5,161 pounds.

Soybeans planted alone were the least productive of all crops and mixtures tested, producing only 3,243 pounds of dry matter per acre. Even though they contained the highest percent of protein, the protein yield per acre was lower than for other crops and mixtures. When soybeans were planted with millet, the protein content of the mixture was

significantly higher than for millet alone, but soybeans did not improve the protein content of other mixtures.

Millet and sudangrass had a higher weight per plant when grown with other crops than when grown alone. This indicates that both millet and sudangrass are highly competitive with themselves as compared with other species when grown in association. Millet produced 5,090 pounds of dry matter per acre as compared to 4,507 pounds for sudangrass.

The yields of complex mixtures of corn-soybeans-millet-sweet sorghum or corn-soybeans-sudangrass-sweet sorghum were not significantly different from those of corn grown alone, corn-sweet sorghum, corn-velvet beans, sweet sorghum grown alone, grain sorghum, and millet grown alone. Individual plants in the two complex mixtures were reduced in weight with the exception of millet and sudangrass; the latter two species weighed considerably more in mixtures.

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APPENDIX

FIRST CUTTING PLOT WEIGHTS IN POUNDS

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
1	27.0	23.6	24.6	14.6	22.45
2	11.2	16.8	12.5	13.1	13.40
3	15.6	24.4	17.1	18.8	18.98
4	12.8	14.4	12.4	12.8	13.10
5	23.0	25.9	19.6	16.8	21.33
6	23.2	24.1	29.9	26.4	25.90
7	19.4	20.0	19.8	18.9	19.53
8	26.0	29.1	21.9	26.1	25.78
9	16.6	15.5	16.8	17.0	16.48
10	12.9	14.8	14.2	14.9	14.20
11	36.5	33.3	26.5	31.8	32.03
12	16.1	20.0	20.3	19.5	18.98
13	29.3	21.3	23.9	24.6	24.78
14	20.5	16.4	18.2	21.1	19.05

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	13	1,525.02	117.309	13.372**
Replicates	3	25.91	8.633	0.984
Error	39	342.15	8.773	
Total	55	1,893.08		

SECOND CUTTING POUNDS PER ACRE

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
3	419	779	354	441	498
4	1568	1513	1448	1296	1456
9	692	675	659	550	644
10	926	757	822	561	767
12	735	653	822	708	755
14	1459	800	839	686	946

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	5	11,934,006	2,386,801	68.4**
Replicates	3	88,635	29,545	
Error	15	523,611	34,907	
Total	23	12,546,252		

TOTAL YIELD IN POUNDS PER PLOT

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
1	27.00	23.60	24.60	14.60	22.45
2	11.20	16.80	12.50	13.10	13.40
3	17.33	27.62	18.56	20.62	21.03
4	17.28	20.66	18.39	18.16	18.63
5	23.00	25.90	19.60	16.80	21.33
6	23.20	24.10	29.90	26.40	25.90
7	19.40	20.00	19.80	18.90	19.53
8	26.00	29.10	21.90	26.10	25.78
9	19.46	18.29	19.52	19.27	19.13
10	16.73	17.93	17.60	17.22	17.38
11	36.50	33.30	26.50	31.80	32.03
12	19.14	22.70	23.70	22.43	22.00
13	29.30	21.30	23.90	24.60	24.78
14	26.53	17.87	21.67	23.94	22.50

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	13	1,041.23	80.094	8.096**
Replicates	3	29.81	9.937	1.004
Error	39	385.82	9.893	
Total	55	1,456.86		

POUNDS NITROGEN PER PLOT

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
1	.454	.333	.433	.251	.368
2	.267	.422	.289	.317	.324
3	.260	.472	.358	.363	.363
4	.354	.424	.421	.341	.385
5	.400	.513	.351	.252	.379
6	.311	.424	.592	.597	.481
7	.281	.332	.317	.280	.303
8	.419	.506	.368	.436	.432
9	.424	.355	.394	.455	.407
10	.289	.308	.331	.324	.313
11	.642	.573	.612	.582	.602
12	.322	.615	.424	.493	.464
13	.460	.315	.482	.396	.413
14	.573	.336	.373	.462	.436

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	13	0.319	0.025	3.57**
Replicates	3	0.009	0.003	0.43
Error	39	0.269	0.007	
Total	55	0.597		

PERCENT CALCIUM IN CROPS OR MIXTURES

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
1	0.45	0.52	0.58	0.68	0.558
2	0.97	0.56	0.58	0.51	0.655
3	0.50	0.48	0.63	0.39	0.500
4	0.52	0.58	0.70	0.70	0.625
5	0.46	0.54	0.49	0.61	0.525
6	0.57	0.36	0.48	0.62	0.501
7	0.52	0.68	0.62	0.61	0.608
8	0.62	0.49	0.52	0.54	0.543
9	0.46	0.53	0.58	0.58	0.538
10	0.48	0.58	0.58	0.96	0.650
11	0.63	1.06	0.98	0.45	0.780
12	0.52	0.48	0.41	0.48	0.473
13	0.68	0.58	0.70	0.61	0.643
14	0.63	0.60	0.61	0.46	0.575

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	13	0.348	0.027	1.5 N.S.
Replicates	3	0.009	0.003	0.166
Error	39	0.711	0.018	
Total	55	1.068		

PERCENT PHOSPHOROUS IN CROPS OR MIXTURES

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
1	0.18	0.22	0.22	0.16	0.195
2	0.18	0.22	0.17	0.18	0.188
3	0.18	0.18	0.17	0.16	0.173
4	0.22	0.17	0.17	0.17	0.183
5	0.17	0.17	0.14	0.18	0.165
6	0.16	0.16	0.20	0.16	0.170
7	0.12	0.15	0.16	0.19	0.155
8	0.14	0.15	0.18	0.18	0.163
9	0.18	0.16	0.17	0.15	0.165
10	0.16	0.13	0.18	0.17	0.160
11	0.14	0.22	0.18	0.14	0.170
12	0.20	0.14	0.16	0.21	0.178
13	0.20	0.15	0.15	0.17	0.168
14	0.20	0.17	0.16	0.14	0.168

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	13	0.007	0.00054	0.853
Replicates	3	0.001	0.00033	0.541
Error	39	0.024	0.00061	
Total	55	0.032		

PERCENT POTASSIUM IN CROPS OR MIXTURES

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
1	1.18	2.10	2.30	1.61	1.798
2	1.52	1.69	2.10	1.94	1.813
3	1.88	1.86	1.88	0.83	1.612
4	1.79	1.28	1.42	1.90	1.598
5	1.45	1.42	1.07	2.32	1.565
6	1.14	1.09	2.05	2.27	1.638
7	1.22	0.91	1.39	2.07	1.397
8	0.97	1.66	1.66	1.26	1.388
9	1.77	1.52	1.37	1.80	1.615
10	1.56	1.29	1.38	1.50	1.432
11	1.46	1.88	1.38	1.36	1.520
12	1.91	1.29	1.29	1.91	1.600
13	1.20	1.35	1.29	1.31	1.288
14	1.42	1.24	1.52	1.22	1.350

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	13	1.29	0.099	0.702 N.S.
Replicates	3	0.39	0.130	0.921
Error	39	5.49	0.141	
Total	55	7.17		

PERCENT MAGNESIUM IN CROPS OR MIXTURES

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
1	0.34	0.42	0.32	0.53	0.403
2	0.42	0.34	0.37	0.36	0.373
3	0.37	0.32	0.44	0.20	0.333
4	0.78	0.54	0.48	0.41	0.553
5	0.32	0.37	0.29	0.39	0.343
6	0.42	0.27	0.36	0.29	0.335
7	0.27	0.66	0.44	0.36	0.433
8	0.44	0.27	0.32	0.38	0.353
9	0.38	0.37	0.28	0.49	0.380
10	0.37	0.34	0.42	0.43	0.390
11	0.45	0.46	0.42	0.26	0.398
12	0.34	0.32	0.25	0.25	0.290
13	0.30	0.49	0.36	0.41	0.390
14	0.22	0.54	0.53	0.24	0.383

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	13	0.212	0.016	1.60 N.S.
Replicates	3	0.018	0.006	0.60
Error	39	0.392	0.010	
Total	55	0.622		

SWEET SORGHUM WEIGHT PER PLANT IN GRAMS

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
1	40.4	62.9	53.3	68.0	56.15
7	36.4	47.8	62.5	52.2	49.73
8	12.8	21.4	21.3	15.2	17.68
12	13.7	9.1	12.1	16.1	12.75
14	14.5	16.5	17.3	19.1	16.85

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	4	6,773.22	1,693.30	37.92**
Replicates	3	350.61	116.87	2.62
Error	12	535.83	44.65	
Total	19	7,659.66		

SWEET SORGHUM HEIGHT PER PLANT IN INCHES

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
1	71	72	68	65	69.00
7	50	58	53	51	53.00
8	53	48	45	49	48.75
12	47	36	41	43	41.75
14	56	52	48	39	48.75

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	4	1,663.50	415.88	22.71**
Replicates	3	102.55	34.18	1.87
Error	12	219.70	18.31	
Total	19	1,985.75		

SOYBEAN WEIGHT PER PLANT IN GRAMS

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
2	25.3	28.9	19.3	26.0	24.88
7	15.7	15.8	15.8	17.3	16.15
9	2.8	2.0	2.0	2.3	2.28
10	2.5	4.0	2.2	2.6	2.83
11	7.5	11.8	8.8	7.3	8.85
12	1.6	1.7	1.9	4.0	2.30
14	2.3	2.3	3.6	1.3	2.38

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	6	1,894.78	315.80	95.12**
Replicates	3	12.67	4.22	1.27
Error	18	59.68	3.32	
Total	27	1,967.13		

SOYBEAN HEIGHT PER PLANT IN INCHES

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
2	40	39	41	42	40.50
7	38	29	41	40	37.00
9	26	25	26	27	26.00
10	29	28	27	25	27.25
11	29	35	39	31	33.50
12	29	21	26	27	25.75
14	33	30	28	26	29.25

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	6	805.86	134.31	12.69**
Replicates	3	35.82	11.94	1.13
Error	18	190.43	10.58	
Total	27	1,032.11		

MILLET WEIGHT PER PLANT IN GRAMS

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
3	2.7	3.8	2.7	3.3	3.13
9	6.1	6.2	5.5	5.5	5.83
12	9.0	9.1	15.5	11.4	11.25

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	2	136.99	68.50	18.17**
Replicates	3	6.41	2.14	0.57
Error	6	22.63	3.77	
Total	11	166.03		

MILLET HEIGHT PER PLANT IN INCHES

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
3	31	34	46	36	36.8
9	38	42	38	37	38.8
12	43	38	38	47	41.5

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	2	45.50	22.75	0.78
Replicates	3	22.67	7.56	0.26
Error	6	175.83	29.30	
Total	11	244.00		

SUDAN WEIGHT PER PLANT IN GRAMS

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
4	2.2	1.7	2.0	1.7	1.90
10	2.9	2.8	2.6	2.1	2.60
14	2.8	4.7	4.3	3.9	3.93

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	2	8.46	4.23	12.44**
Replicates	3	.54	.18	.53
Error	6	2.03	.34	
Total	11	11.03		

SUDAN HEIGHT PER PLANT IN INCHES

Crop or Mixture No.	Replicates				Average
	I	II	III	IV	
4	47	47	46	48	47.0
10	45	57	48	48	49.5
14	57	51	53	44	51.3

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	2	36.50	18.25	0.82 N.S
Replicates	3	38.25	12.75	0.57
Error	6	133.50	22.25	
Total	11	208.25		

CORN WEIGHT PER PLANT IN GRAMS

Crop or Mixture No.	Replicates I	II	III	IV	Average
6	85.4	101.4	81.8	124.5	98.28
8	93.9	43.3	90.8	83.8	77.95
11	90.1	111.4	93.0	106.8	100.32
12	25.9	15.8	16.7	15.4	18.45
13	94.6	112.8	94.9	99.0	100.32
14	34.1	18.3	12.6	17.2	20.55

Analysis of Variance

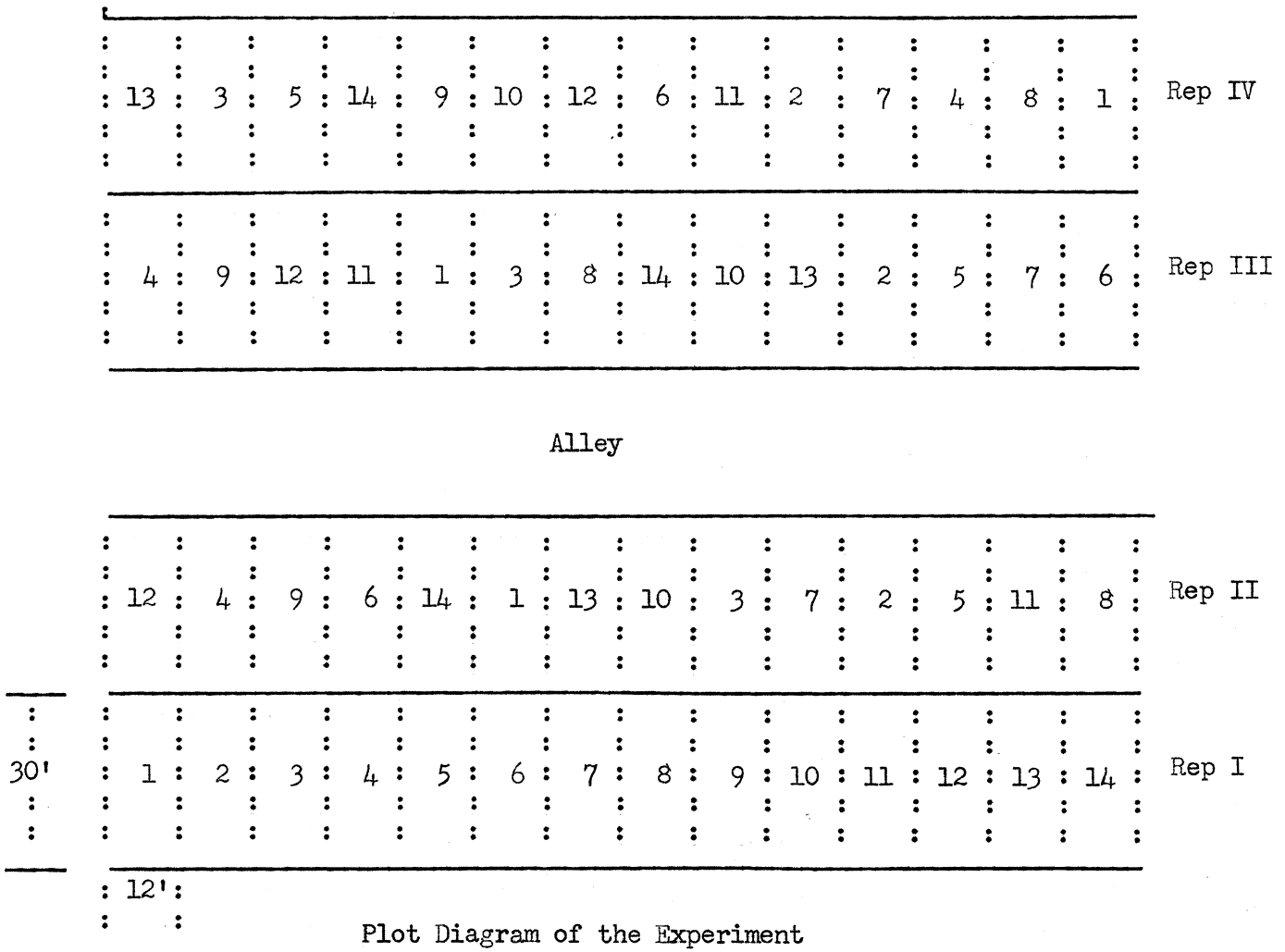
Source of Variance	df	SS	Ms	F
Treatments	5	31,207.04	6,241.41	27.87**
Replicates	3	310.32	103.44	.46
Error	15	3,359.11	223.94	
Total	23	34,876.47		

CORN HEIGHT PER PLANT IN INCHES

Crop or Mixture No.	Replicates I	II	III	IV	Average
6	62	71	71	86	72.50
8	71	73	70	60	68.50
11	84	77	71	73	76.25
12	36	30	33	41	35.00
13	85	77	73	70	76.25
14	34	35	37	33	34.75

Analysis of Variance

Source of Variance	df	SS	Ms	F
Treatments	5	8,069.71	1,613.94	35.91**
Replicates	3	24.13	8.04	0.18
Error	15	674.12	44.94	
Total	23	8,767.96		



Plot Diagram of the Experiment