YIELD AND QUALITY OF A SORGHUM X SUDANGRASS HYBRID AS AFFECTED BY VARIOUS MIXTURES OF A GRAIN SORGHUM

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CHAPTER I

INTRODUCTION

Of the total farm land in the United States, nearly two-thirds of it is classified as forage-producing land. The forage produced on this land varies tremendously in kind, yield, and quality. Most of the forage has little or no value until it is marketed through livestock, principally cattle. In this form the forage has an estimated value of approximately eight billion dollars annually. Much research has been expended in attempts to increase the yield of forage crops, and an increasing amount of research is being conducted concerning the quality of forages.

It is important to have a high-quality forage as well as a high-yielding forage. Summer annual grasses for pasture and silage are ideal late summer supplements to perennial grasses which may be decreasing in quality and quantity at this time of the year. Sudangrass and its hybrids are the most widely grown of the summer annual grasses. In recent years the sorghum x sudangrass hybrids have become more widely grown than sudangrass. While no accurate figures are available, it is believed that more than one-half of the 415,000 acres of forage sorghum grown in Oklahoma in 1969 was sorghum x sudangrass hybrids. The hybrids are also widely grown in other states throughout the South and Southwest.

One problem with the production of sorghum x sudangrass hybrid seed is the maintenance of purity. The two main sources of contamination are outcrossing caused by contamination from foreign pollen and selfing caused by fertile pollen from the supposedly sterile plants. Under state seed laws, no seed can be labeled as hybrid if off-type plants constitute more than five percent of the total.

The objective of this experiment was to determine the effects of various mixtures of selfs on yield and quality of a sorghum x sudangrass hybrid.

CHAPTER II

LITERATURE REVIEW

The advantages of hybrids over open-pollinated or inbred varieties have been demonstrated in many crops. Thus, hybridization has been receiving increased attention from many forage crop breeders. Most forage crops, however, present considerable problems to hybrid seed production on the extensive scale required for a commercial hybrid program. The predominant problems are their small, perfect flowers, few seeds per flower, and high seeding rates (a large number of seeds required per acre).

Several methods have been proposed in attempts to overcome these obstacles. Karper and Quinby (11) suggested the use of bulk emasculation with hot water, or the utilization of "antherless" or male-sterile abnormalities to facilitate the production of hybrid sorghum seed on a commercial scale. Stephens (17) offered a detailed plan for producing hybrid sorghum seed, using the recessive male-sterility factor. Suneson (18) suggested that mass emasculation in wheat might be accomplished by chilling. Atwood (2) isolated genes for self-compatibility and self-incompatibility and considered the possibility of using these genes in the production of F_1 hybrid seed of Trifolium repens.

A method of producing hybrid alfalfa seed was presented by Tysdal and Kiesselbach (21) after thorough consideration of the problems.

They considered competition as a factor in determining the yields obtained from hybrid seed, which, according to their plan, would carry a certain percentage of selfed or sibbed seed from the parent plants. When they compared the yield performance of Ladak alfalfa, a low-yielding inbred, and mechanical mixtures of the two varieties, they found that the mixtures yielded more than might be expected on the basis of the yields of the individual components of the mixtures. The mixture containing 75 percent Ladak and 25 percent selfed lines produced forage yields that were 96.5 percent of the yield of Ladak grown in pure culture, whereas, theoretically it should have yielded 89.5 percent of the Ladak yield. The 50:50 mixture also outyielded expectations, producing 89.6 percent against a theoretical yield of 79 percent. It was thus apparent that the higher yielding plants benefited from reduced competition of the less vigorous and lower yielding plants. Tysdal and Kiesselbach thus concluded that it would apparently require a relatively high percentage of selfing in order to detract greatly from the hybrid yield.

On the other hand, Carnahan and Paden (5), using different varieties, found that as little as 10 percent selfed seed depressed alfalfa forage yields a highly significant amount. Each successive amount of S_1 seed in the admixture also reduced forage yields significantly. Considering the yield of the 2-clone combination as 100 percent, dilution with 10, 25, and 50 percent S_1 seed resulted in yields of 98.3, 96.1, and 92.6 percent, respectively. Lahontan, included as the check variety, yielded 96.97 percent as much as the 2-clone combination. The greatest yield depression occurred at the lowest of three seeding rates tested, and least yield depression occurred at the highest

seeding rate tested.

Carnahan and Paden (5) tested five S_1 lines and found that four of the five lines yielded similarly, averaging 78.1 percent as much as the 2-clone combination, while the fifth line yielded 96.8 percent as much as the 2-clone combination. Therefore, diluting the 2-clone combination with S_1 seed of the most vigorous line had less depressing effect on yield than diluting with the less vigorous lines.

At the end of the two year test, plots seeded with the 2-clone combination or pure S_1 lines had similar plant stands and contained more plants than the plots seeded with mixtures of seed. This strongly suggested that competition for establishment and survival occurred to a greater extent in the mixed populations. Competition, however, was not completely effective in eliminating S_1 plants from the population as evidenced by the significant effect of dilutions on forage yields.

Studies begun with pearl millet, Pennisetum typhoides (Burm.) Stapf, in 1936 revealed that the annual grass was highly cross pollinated and lost vigor upon selfing. The increased yield shown by certain hybrid combinations indicated that the maximum yield in pearl millet could be obtained in the F_1 hybrid progeny of two lines carrying high combining ability (4). Self-sterility was observed in many lines, but the difficulties associated with maintaining and using such lines in a commercial seed production program of an annual grass were so great as to make their use impractical.

Pearl millet is commonly seeded in the South at a rate of 10 pounds per acre in 30-inch rows (approximately four seeds per inch of row). Observations of such plantings indicated that many of the seedlings were eliminated by competition quite early in their life

cycle. It was also observed that many millet hybrids were more vigorous than their inbred parents. It was, therefore, logically assumed that inbred seedlings in a mixture with hybrid seedlings might be eliminated within a few weeks and that thereafter the mixture might be expected to behave as a pure hybrid planting. If this were true, it would be possible to produce seed capable of giving the yield increase of pure hybrid seed by harvesting all seed from a field planted to a mixture of several lines with high combining ability. Under ideal conditions, one could expect such a mixture of four lines to produce up to 75 percent hybrid seed and 25 percent selfed or sibbed seed if the lines were completely self-fertile (4). Such a method of producing hybrid seed would be very practical provided good seed-producing inbreds could be obtained.

Burton (4) mixed F_1 hybrid pearl millet seed with selfed seed of its parent inbreds (mixed in equal parts) to make the "parent-hybrid" mixtures. Selfed seed in the proportions of 10, 20, 50, and 80 percent were mechanically mixed and planted at a rate of about four seeds per inch of row. Yields of the parent-hybrid mixtures were compared with those of the 100 percent hybrid and the 100 percent parents. Yield data for six years showed that the 10 percent and 20 percent mixtures actually outyielded the 100 percent hybrid plantings with the 50:50 mixture yielding only slightly less (not statistically significant). The parent-hybrid mixtures in general yielded more than was expected on the basis of yields of the parents and hybrids in pure stands.

In only one year did the yields approach the expected. A prolonged drought following planting resulted in stands so poor that there

probably was little or no competition between individual plants in the seedling stage that year. Under such conditions, nearly all of the parents as well as the hybrid plants survived throughout the course of the test. In all other years, good stands were obtained. In these years most, if not all, of the less vigorous parent seedlings were eliminated by early competition and thereafter the mixtures behaved essentially as pure hybrids.

The proposal by Burton (4) and Tysdal and Kiesselbach (21) that a thick seeding rate was necessary to eliminate most of the lower yielding inbreds was borne out by an experiment initiated by Burton in 1943. Comparing seeding rates of two and one-half, five, and twenty pounds per acre, Burton found that thin seedings of two and one-half and five pounds per acre resulted in yield increases over the theoretical yields that were too small to be significant. Seedling competition at these low seeding rates was not great enough to eliminate the parent seedlings. Seeding at the rate of 20 pounds per acre (double the optimum rate) eliminated the parent seedlings but also depressed the yield of the aftermath of the hybrids.

Syakudo and Kawabata (19) also obtained results indicating that a mixed planting of inbred lines was a satisfactory method of producing hybrid seeds (along with a certain percentage of selfed or sibbed seed from the parent plants) of a highly cross-pollinated crop. They found that the forage production of an 80 percent hybrid mixture of the legume Renge (Astragalus sinicus L.) planted at a thick seeding rate did not differ significantly from that of the pure hybrid seeds.

Bond et al. (3) worked with field beans (Vicia faba L.) and obtained yields with one-third inbred and two-thirds hybrid mixtures

that were quite similar to yields of the pure hybrid plots. Both hybrids and all mixtures containing up to one-third inbred material yielded significantly more than the open-pollinated control varieties.

The two hybrids responded differently to admixtures of inbred material. One hybrid tended to give lower yields than expected whereas the other hybrid consistently gave higher yields than expected. This difference between hybrids was not observed by Burton (4). The three pearl millet hybrids that he tested performed so nearly the same that he computed the average of the three and reported the pooled data.

The experiment with beans differed in two important respects from the experiment with pearl millet: (1) the two hybrids studied did not behave alike, and (2) elimination of seedlings was negligible, i.e., while Burton harvested only hybrids when mixtures of hybrids and inbreds were sown in dense plantings, a mixture of beans was harvested from a normal rate of a mixed seeding. In the case of limited seedling competition, between-neighbor effects became important (3). The different yield patterns in beans apparently occurred because the hybrid which produced above the expected yield possessed greater vegetative vigor.

Variety mixtures have been tested for many different crop species in attempts to increase yields. Jensen (10) tested oat varieties alone and in various mixtures. Blends did not yield significantly higher. Patterson et al. (14) also worked with oats and found blends to be somewhat superior in standability but not in yield.

Mumaw and Weber (13) reported composites of soybean varieties yielded significantly above the pure lines with the greatest advantage for blends of diverse types. Probst (15) compared three soybean

varieties with all possible blends. The varieties differed markedly in maturity and height and to a limited extent in growth type, lodging susceptibility, and reaction to several diseases. In general, blends were not superior in yield to the highest yielding parent variety but averaged 2.2 percent higher than the pure-line average. A marked variety x season interaction existed for yield, and blending had a stabilizing effect in this respect.

Allard (1) found that simple mechanical mixtures of two or three pure lines of lima beans consistently produced less than the average of component pure lines grown singly. Genetically complex populations derived by bulk propagation from hybrids between the same parents yielded as much as the superior pure-line parent or more. It was suggested that simple mixtures contained too few genotypes to be efficient in exploiting all available ecological sites. Pure-line populations were less stable in productivity than mixed populations. It was concluded that mixtures appeared to be insurance against very low yields, but the genetic and ecological forces that produce stability in production do not necessarily endow mixtures with high average productive capacity.

Hanson *et al.* (7) determined the yield of five apomictic Kentucky bluegrass strains grown individually in broadcast plots and as all possible composites of two, three, four, or five strains. The five strains represented a range in morphological types. Eleven of twenty-six combinations exceeded the yield of the highest yielding component strains over a two-year period. Six combinations yielded significantly more than the commercial check, though none of the pure strains significantly outyielded the check.

Ross (16) grew five grain sorghum single-cross hybrids of varying genotypes alone and in 1:1 blends for five years. Average yield of all blends was not significantly different from the average of all hybrids alone. No blend yield exceeded that of the best hybrid. Blends significantly outyielded the hybrids only one year, one characterized as extremely favorable for high yields. Significant differences within blends and within hybrids existed each year. Only two of fifty individual blends deviated significantly from expected yields when analyzed by the "t" test. None of the ten blends yielded significantly different from expectations over the five year period.

Funk and Anderson (6) found that blending of two or more corn hybrids, either in the same hill, in alternate hills, or in alternate rows, did not increase grain yields over the mean of the component hybrids grown separately. Hybrids showed considerable differences in competitive ability, and the actual contribution of the individual components of a mixture differed widely from what would be expected on the basis of their yields in pure stands. Blending corn hybrids was found to increase yield stability with a decrease in the entry x location interaction.

Hanson et al. (8) tested the performance of alfalfa varieties, variety crosses, and variety mixtures at nine locations. The average yields of eleven crosses and corresponding mixtures were 104 and 103 percent of the average midparent value. Crosses and mixtures each averaged 97 percent of the average high-parent value. Statistically, these deviations were highly significant. Only one variety mixture outyielded the high component variety. Eight of the eleven mixtures yielded significantly more than the average of component varieties.

It was concluded that neither the alfalfa variety crosses nor variety mixtures would contribute substantially to increasing the yield over the highest yielding variety at a particular location.

CHAPTER III

MATERIALS AND METHODS

A study was initiated in the summer of 1969 to determine the yield and quality of a sorghum x sudangrass hybrid as affected by various mixtures of a grain sorghum. Quality traits measured were *in vitro* dry matter digestibility and protein content. The study was repeated in the summer of 1970. The tests were conducted at the Agronomy Research Station near Perkins, Oklahoma, on a Vanoss fine sandy loam soil.

The study consisted of seven treatments (Table I) with each treatment replicated four times. The various percentages of grain sorghum in each treatment were obtained by weighing out the proper amount of the hybrid (A Redlan x Greenleaf) and mechanically mixing it with the proper amount of the grain sorghum (B Redlan). The seeds were planted with a Planet Jr. vegetable seed planter on June 4, 1969, and June 8, 1970, at a rate of 20 pounds of seed per acre. Five 20 foot rows spaced one foot apart were used for each treatment. Nitrogen as ammonium nitrate was applied at the rate of 80 pounds per acre in split applications of 40 pounds each. One application was made approximately two weeks after planting and the second after the second harvest each year. In 1969 approximately two inches of irrigation water were applied in early August. In 1970 approximately one inch of irrigation water was applied immediately after seeding to ensure rapid

and uniform plant emergence, and one and one-half inches were applied one week later.

TABLE I

COMPOSITION OF ENTRIES

Entry Number	% Hybrid*	% B Redlan
1	100	0
2	90	10
3	80	20
4	70	30
5	60	40
6	50	50
7	0	100

* Hybrid is A Redlan x Greenleaf

Forage yields were determined for four harvests in 1969 and for three harvests in 1970. For each plot, three 20 foot rows were clipped with a Jari mower at heights to leave a four to six inch stubble and weights in pounds of fresh plant material were determined. Forage samples of 250 to 400 grams were taken from each plot for dry matter determinations. Yields were calculated in pounds of oven dry matter per acre, and the yields from all harvests within a year were added to get the total yield for each year. Harvests in 1969 were

made on July 7, July 25, September 5, and November 12. In 1970 harvests were made on July 15, August 7, and October 2. Oven dried plant samples from each plot at each harvest were used for dry matter digestibility and protein content determinations. The plant samples were ground with a Wiley mill which was equipped with a 40 mesh screen.

The method of Tilley and Terry (20) was used to determine *in vitro* digestibility of the forage. For *in vitro* rumen digestion, one gram of ground, oven-dry material was placed in a 250 ml. centrifuge bottle. Eighty ml. of buffer solution of McDougall's (12) artificial sheep saliva and 20 ml. of strained rumen liquor were added to each bottle. All bottles were made anaerobic with carbon dioxide, sealed with a cork gas release valve, and incubated 48 hours in darkness at a temperature of 38 C. The samples were gently agitated at four to five hour intervals to mix the contents.

For pepsin digestion, bacterial activity in all bottles was stopped by placing the bottles under refrigeration at 2 C. The bottles were centrifuged 18 minutes at 7,000 rpm, and the supernatant was discarded. One hundred ml. of pepsin (2 grams 1: 10,000 pepsin in 1,000 ml. of 0.1 N HCl) was added, and the bottles were incubated at 38 C. for 48 hours with occasional shaking to mix the contents. Most of the supernatant was discarded, and the residue, along with the remaining supernatant, was transferred to a tared weighing container and dried at 70 C. The weight of the blanks was then subtracted from the sample weight. The percentage of digestibility was calculated for each 100 grams of sample dry matter.

Protein determinations were made by the Winkler modification of the macro-Kjeldahl method as described by Jacobs (9). A one gram

sample of ground oven-dried forage was transferred into an 800 ml. macro-Kjeldahl flask and 10 grams of sodium sulfate, two or three granules of selenium, and 25 ml. of concentrated sulfuric acid were added. The flask was placed on the digestion rack for 60 to 70 minutes during which time the organic material was reduced to carbon dioxide, water, and ammonia. The ammonia, containing the nitrogen from protein degradation, was trapped in the form of ammonium sulfate, a substance with a high boiling point. After cooling, 300 to 350 ml. of water were added to each sample. After the addition of 75 ml. of 50 percent sodium hydroxide and zinc boiling chips, the flasks were placed on the distillation rack. The ammonia, liberated from ammonium sulfate in an alkaline medium, was distilled into receiving flasks containing 50 ml. of a 5 percent solution of boric acid with methylene blue added as an indicator. The first 150 ml. of the distillate would contain all of the ammonia. The ammonia was titrated directly with 0.1253 N sulfuric acid until the solution began to regain its blue color or until no green could be seen. One ml. of the standard acid required for titration was equivalent to one percent protein for wheat and flour but had to be multipled by the factor 1.0965 for feed grains and forages.

CHAPTER IV

RESULTS AND DISCUSSION

Dry matter yields were very high in 1969 but declined to lower values in 1970. Two major factors influenced yields--(1) stored moisture and fertility were high in 1969 since the test area was summer fallowed in 1968 after having been in alfalfa for several years, and (2) rainfall was extremely low during the latter half of July, August, and early September of 1970. Yields were also highly variable from harvest to harvest within years. This was probably due primarily to differences in physiologic maturity at harvest and to differences in rainfall distribution.

In 1969 the 90:10 mixture (90% A Redlan × Greenleaf and 10% B Redlan) produced the most forage, yielding significantly higher than the 80:20, 70:30, 50:50, and B Redlan entries (Table II and Figure 1). The 100 percent hybrid produced the second highest yield but only yielded significantly higher than the 50:50 mixture and the B Redlan. All entries yielded significantly higher than the B Redlan in all harvests except the first. The B Redlan yielded 79 percent as much as the pure hybrid in the first harvest but only 45 percent for the year's total; thus demonstrating a low regrowth potential.

In 1970 the 80:20 mixture produced the most forage but yielded less than 100 pounds more than the hybrid and the 70:30 mixture (Table II and Figure 1). The 90:10 mixture did not yield as much as

TABLE II

FORAGE PRODUCTION AS INFLUENCED BY HYBRID AND PARENTAL MIXTURES
(lbs. oven dry matter/acre)

Year	Harvest Date	Treatment (% Hybrid and % B Redlan) 100:0	90:10	80:20	70:30	60:40	50:50	0:100	C.V.
1969	July 7	3140 a	3307 a	2743 a	3135 a	2870 a	2939 a	2481 a	14.5
	July 25	2187 ab	2593 a	1897 b	1965 b	2233 ab	1847 b	651 c	19.8
	Sept. 5	4803 a	5000 a	4830 a	4332 ab	4565 ab	3979 b	1230 c	10.4
	Nov. 12	2181 a	2651 a	2087 a	2115 a	2294 a	2294 a	1138 b	23.3
	Total	12311 ab	13551 a	11557 a	11547 bc	11962 abc	11059 c	5499 d	10.6
1970	July 15	2991 a	2681 ab	2713 ab	2711 ab	2496 b	2515 b	1714 c	8.9
	Aug. 7	1712 a	1654 a	1875 a	1942 a	1780 a	1876 a	2042 a	10.0
	Oct. 2	2480 a	2278 a	2627 a	2469 a	2200 a	2259 a	801 b	12.0
	Total	7183 ab	6613 cd	7215 a	7122 abc	6476 d	6650 bcd	4557 e	5.2
2 year avg.		9747 ab	10082 a	9386 ab	9334 ab	9219 ab	8854 b	5028 c	7.5

Values within a harvest date followed by the same letter are not significantly different from each other at the 0.05 level according to Duncan's Multiple Range Test.

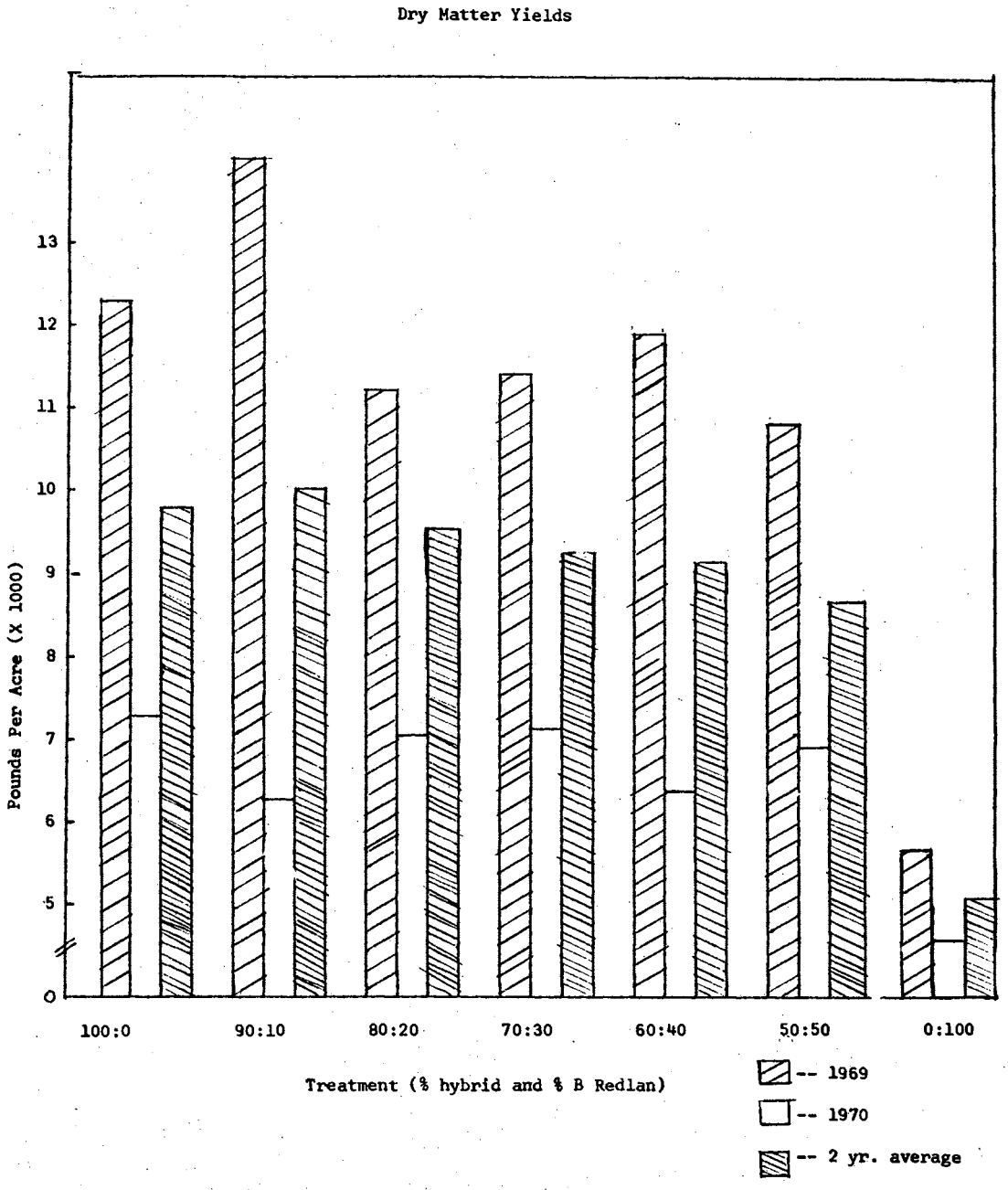

Figure 1. Total Dry Matter Yields for Treatments and Years

expected, producing significantly less than the pure hybrid and the 80:20 mixture. The pure hybrid again produced the second highest yields, producing significantly more than the 90:10 and 60:40 mixtures and the B Redlan. For some unknown reason the B Redlan was the highest yielding entry for the second harvest but the differences were not statistically significant. This was the only harvest in either year in which the B Redlan yields approached those of the other entries.

The highest two-year average forage production was by the 90:10 mixture but it was statistically higher than only the 50:50 mixture and the B Redlan. The hybrid was the second highest yielder but it significantly outyielded only the B Redlan. These results closely agree with those obtained by Burton (4) whose 90:10 and 80:20 parent-hybrid mixtures outyielded the 100 percent hybrid pearl millet.

Average yields of all mixtures were higher than expected, based upon the yields of each component of the mixture (Figure 2). Greatest differences between actual and expected yields occurred at the greatest dilutions, the 60:40 and the 50:50 mixtures. Burton (4) also obtained greatest differences between actual and expected yields with a 50:50 mixture of hybrid and inbred parent seed.

In vitro dry matter digestibility differences were non-significant for all harvests in 1969 although the second harvest approached significance at the 0.05 level (Table III and Figure 3). For the entire year the 70:30 and 80:20 mixtures had non-significantly higher digestibilities than the other entries. The digestibility of all entries was above 59 percent which indicated that the forage was high quality. Much of the differences between harvests was probably due to differences between the incubators in the laboratory. Duplicate samples

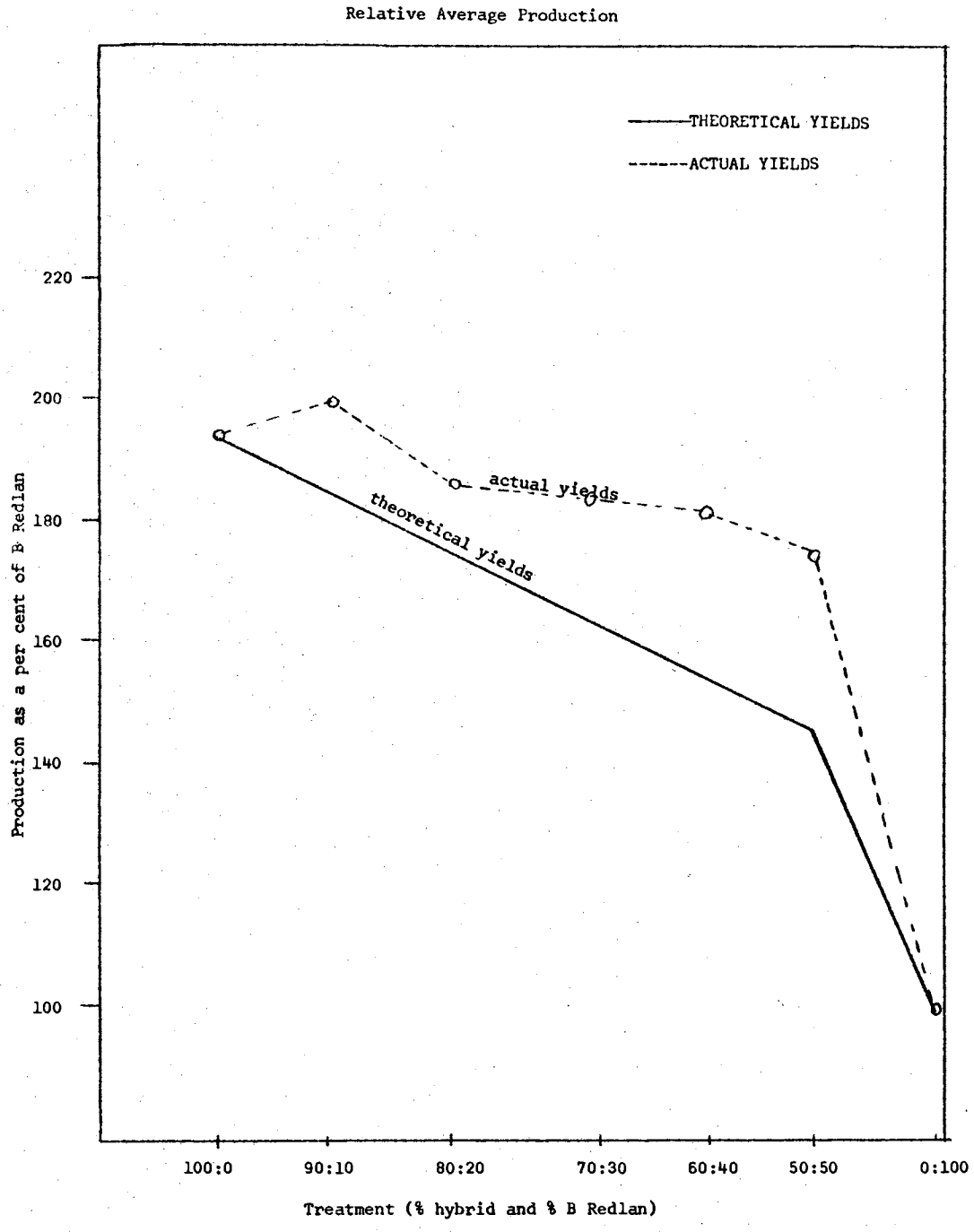

Figure 2. Actual Forage Production Compared with Theoretical Yields Based upon Production of the 100% Hybrid and 100% B Redlan

TABLE III

DRY MATTER DIGESTIBILITY AS INFLUENCED BY HYBRID AND PARENTAL MIXTURES
(percent of oven dry weight)

Year	Harvest Date	Treatment (% Hybrid and % B Redlan) 100:0	90:10	80:20	70:30	60:40	50:50	0:100	C.V.
1969	July 7	64.13 a	63.35 a	63.25 a	64.66 a	64.93 a	65.45 a	62.98 a	2.2
	July 25	58.13 a	56.33 a	60.07 a	61.20 a	55.37 a	58.29 a	58.95 a	4.2
	Sept. 5	60.32 a	62.88 a	62.49 a	63.33 a	63.00 a	62.21 a	61.74 a	4.5
	Nov. 12	57.34 a	55.35 a	59.19 a	57.60 a	55.62 a	56.18 a	54.00 a	6.3
	Average	59.98 a	59.48 a	61.25 a	61.70 a	59.73 a	60.53 a	59.42 a	2.8
1970	July 15	63.53 a	64.76 a	64.85 a	65.63 a	65.54 a	65.18 a	66.14 a	3.1
	Aug. 7	65.19 b	64.08 b	66.26 ab	64.52 b	65.47 b	68.22 a	65.31 b	2.3
	Oct. 2	63.03 a	63.51 a	62.31 a	63.58 a	61.99 a	61.96 a	62.60 a	2.8
	Average	63.92 a	64.12 a	64.47 a	64.58 a	64.33 a	65.12 a	64.68 a	1.9
2 year average		61.67 a	61.46 a	62.63 a	62.93 a	61.70 a	62.50 a	61.67 a	1.7

Values within a harvest date followed by the same letter are not significantly different from each other at the 0.05 level according to Duncan's Multiple Range Test.

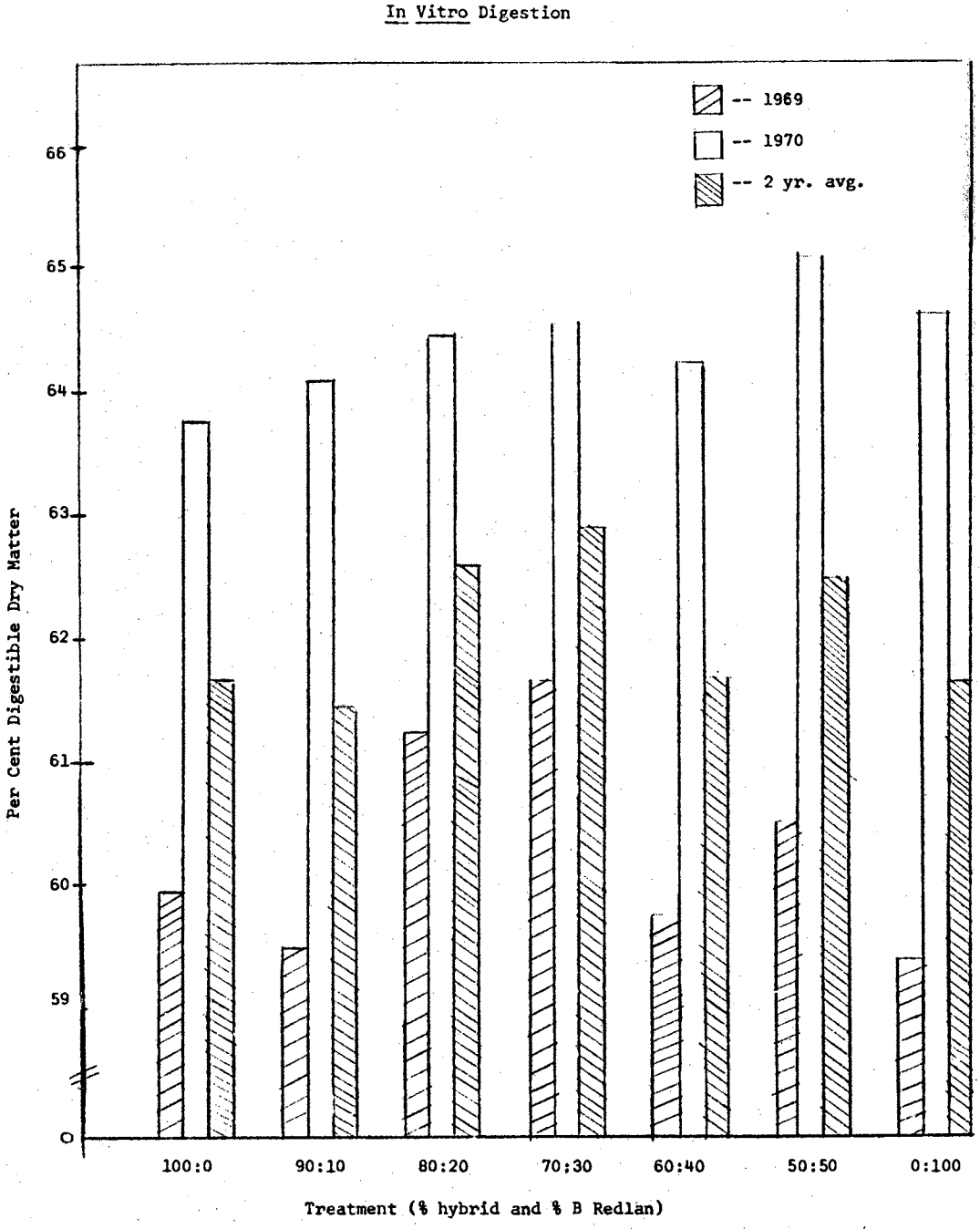

Figure 3. Average In Vitro Dry Matter Digestibilities for Treatments

were run in the same incubator with each harvest run in different incubators.

In 1970 only the second harvest had significant differences in in vitro dry matter digestibility at the 0.05 level (Table III and Figure 3). The 50:50 mixture was significantly more digestible for this harvest than all other entries except the 80:20 mixture. No reasonable explanation for this could be found. Due to the very high digestibility of the 50:50 mixture in the second harvest, this mixture had the highest average digestibility for all harvests during the year. All entries produced high quality forage as evidenced by the fact that there was only 1.20 percent difference in digestibility between the highest and lowest entries. Data for digestibility in 1970 was obtained by testing duplicate samples in two different incubators and averaging the readings of the two incubators.

The data for the two-year average showed no significant differences between entries for in vitro digestibility of dry matter. The 70:30, 80:20, and 50:50 mixtures were the most digestible but there was only 1.47 percent difference between the high and low entries (the 70:30 and 90:10 mixtures, respectively). The hybrid and the B Redlan had identical digestibilities of 61.67 percent for the two-year period. All entries produced a very high quality forage with all entries having dry matter digestibilities above 61 percent.

In 1969 differences in protein content were not significant at the 0.05 level except in the third harvest (Table IV and Figure 4). For this harvest B Redlan was significantly higher in crude protein than all other entries. Due to the slow regrowth of the B Redlan it was in a much more immature stage of growth at harvest than all other entries

TABLE IV

CRUDE PROTEIN CONTENT AS INFLUENCED BY HYBRID AND PARENTAL MIXTURES
(percent of oven dry weight)

Year	Harvest Date	Treatment (% Hybrid and % B Redlan) 100:0	90:10	80:20	70:30	60:40	50:50	0:100	C.V.
1969	July 7	11.65 a	11.51 a	11.54 a	11.57 a	11.32 a	12.01 a	12.94 a	8.9
	July 25	16.97 a	17.68 a	17.93 a	17.74 a	17.65 a	18.37 a	17.93 a	6.7
	Sept. 5	11.29 b	11.60 b	11.54 b	10.89 b	11.46 b	11.10 b	13.85 a	6.8
	Nov. 12	13.27 a	12.67 a	13.41 a	12.75 a	13.54 a	13.21 a	11.41 a	7.1
	Average	13.30 a	13.37 a	13.61 a	13.24 a	13.50 a	13.67 a	14.03 a	3.2
1970	July 15	14.67 b	14.56 b	14.67 b	14.69 b	14.64 b	14.80 b	17.54 a	4.3
	Aug. 7	14.67 a	14.31 a	14.51 a	13.93 a	14.56 a	14.66 a	13.46 a	7.4
	Oct. 2	12.03 ab	11.93 ab	11.93 ab	10.99 b	11.10 b	11.70 ab	13.02 a	6.9
	Average	13.79 b	13.59 b	13.70 b	13.21 b	13.43 b	13.72 b	14.68 a	3.2
2 year average		13.51 b	13.46 b	13.65 b	13.22 b	13.47 b	13.69 b	14.31 a	2.4

Values within a harvest date followed by the same letter are not significantly different from each other at the 0.05 level according to Duncan's Multiple Range Test.

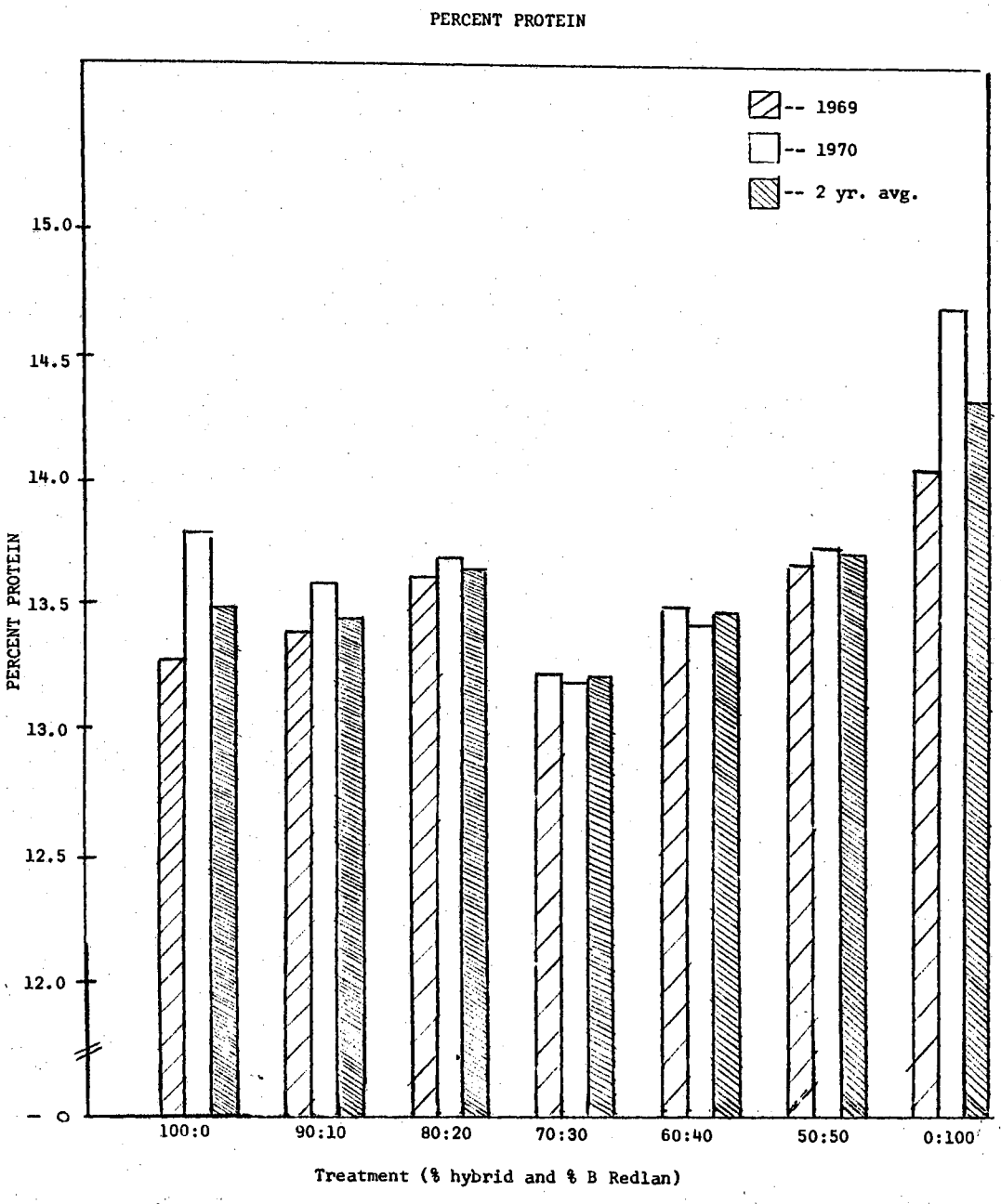

Figure 4. Average Crude Protein Content for Treatments and Years

which probably accounts for the higher protein content. Protein content of all entries was quite high for the second harvest. This was due to the fact that all entries were harvested only 18 days after the first harvest and thus were very immature. The average crude protein content for 1969 revealed a difference of only 0.79 percent between the high and low values (B Redlan and the 70:30 mixture, respectively).

In 1970 there were significant differences in protein content for the first and third harvests and the yearly average but not the second harvest. The hybrid and all mixtures were remarkably stable in the first harvest with a range in crude protein content of only 0.24 percent. An analysis of variance omitting B Redlan indicated no significant differences at the 0.05 level for any harvest or for the year between the hybrid and the mixtures. Average protein content of the hybrid and all mixtures for 1970 exhibited a range of 0.58 percent with the hybrid being non-significantly higher than the mixtures.

The data for the two-year average shows B Redlan to be higher in protein than the hybrid and all mixtures. This was not entirely unexpected because the B Redlan made slower regrowth and was more immature at harvest than all other entries. The differences between the hybrid and all mixtures were small and not statistically significant.

CHAPTER V

SUMMARY AND CONCLUSIONS

The objective of this study was to determine the effects of various mixtures of selfs on yield and quality of a sorghum x sudangrass hybrid. The seven treatments consisted of: 100% hybrid (A Redlan x Greenleaf), 90% hybrid-10% B Redlan, 80% hybrid-20% B Redlan, 70% hybrid-30% B Redlan, 60% hybrid-40% B Redlan, 50% hybrid-50% B Redlan, and 100% B Redlan.

Dry matter yields of the various mixtures were not significantly lower than the yields made by the 100% hybrid. Only the B Redlan yielded significantly lower than the hybrid. High yields were observed for the 100% hybrid and all mixtures.

There were no significant differences in the dry matter digestibility of all treatments. Digestibility of the 100% hybrid and the B Redlan was identical. Digestibility of all treatments was above 61% which indicated very high quality forage.

Crude protein content of the B Redlan was significantly higher than all other entries. This may have been due to the more immature stage of growth at harvest of the B Redlan. There were no significant differences in protein content between the hybrid and all mixtures.

The results of this experiment would indicate that with the particular hybrid tested that a small percentage of selfs in such hybrids would not decrease total forage yields or lower quality of

forage for *in vitro* dry matter digestibility or protein percentages. One cannot draw general conclusions or make recommendations for other hybrid combinations based on these results since only one hybrid combination was involved.

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