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Headquarters for
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(Agricultural Sciences)
Pantex, Texas 79069

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TEXAS TECH UNIVERSITY CENTER AT AMARILLO, PANTEX, TEXAS 79069

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FOREWORD

A. Max Lennon*

Texas Agricultural Products had a market value of approximately six billion dollars in 1974. Income from the sale of cattle represented almost 40% of that total, as Texas ranked first among the states in beef cattle numbers and number of cattle on feed. Agriculture in Texas is big business.

The College of Agricultural Sciences at Texas Tech University pledges continued support to the Beef Cattle Industry through research and educational activities. The areas of Beef Production with the greatest opportunity for improvement through research have been identified as follow:

1. Reproduction efficiency of the breeding herd
2. Increased use of low-quality roughages
3. Improved efficiency of feed utilization

The Beef Production industry has not been immune to spiraling production costs so prevalent in today's economy. These high production costs, coupled with stagnant market prices, have placed beef producers in an economic predicament. Profit margins have been quite low and often times, nonexistent. Now more than ever, cattle producers must incorporate the latest technology into their management programs. Furthermore, researchers must develop innovative improvements for the beef industry that will permit increased reproductive efficiency as well as improved efficiency of feed utilization.

Texas Tech has received excellent cooperation from the Texas Agricultural Experiment Station, as well as from the producer organizations within the state. In addition, numerous companies involved in the beef industry have been helpful in furthering the progress of our research program.

You are invited to visit our research facilities at any time and your comments will be appreciated.

Should you desire additional information about any of the projects included in this report, please contact the Killgore Beef Center or the Animal Science Department.

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*Professor and Chairman, Department of Animal Science, Texas Tech University, Lubbock, Texas 79409.

CROP RESIDUES FOR WINTERING COWS

William L. Mies*

The use of corn and sorghum stover for wintering steers for short periods of time has been a common practice in the High Plains area for many years. The feasibility of this practice has varied from year to year depending on calf prices and protein supplement costs. Corn and sorghum stubble are relatively good sources of energy and some minerals, but relatively poor sources of protein and phosphorus. Thus their potential use may more closely fit the maintenance needs of wintering cows rather than the higher protein required for stocker steer gain. Two and one-half million acres of irrigated corn and sorghum stubble are available for grazing in the High Plains.[1] This acreage would provide sufficient winter feed for one million beef cows in the High Plains area. A great deal of this feed is now being wasted.

Five alternatives exist for the use of corn and sorghum stubble. The first is to burn the material so as to facilitate preparation of the next years seed bed. The second is to turn the stubble under so as to incorporate organic matter back into the soil. The third is to stock calves on the stubble for 60 to 70 days with added supplemental protein to cause gains of 1.5 to 1.7 lbs per head daily. The fourth is to graze 1 cow per 2 or 3 acres for 100 to 120 days with small amounts of supplemental protein prior to calving. The fifth is to mechanically harvest the stubble and transport it to cows on a small grass acreage or in drylot.

The burning of the stubble appears to be a wasteful practice and probably will not be permitted much longer by air pollution regulatory agencies. The turning under of the stubble for organic matter is a decision which must be made by the farmer depending on the needs and condition of his particular soil. I have already mentioned the stocker steer program which depends on calf and protein prices.

The use of cows to graze corn and sorghum stover allows useage of the forage as well as leaving material in the field for organic matter. It has been estimated that a cow will harvest 25 to 30 percent of the stubble in a field. This then leaves considerable organic matter still in the field for agronomic purposes. Mechanical harvesting will remove approximately twice as much as the cow or 50 to 60 percent of the total forage in the field.

The choice between mechanical harvesting and grazing must take into account the following factors: With mechanical harvesting, twice as many cows can be wintered from a given acreage of stubble, however the machinery used to do this job is very specialized and if the rancher doesn't use a silage program presently, the equipment cost would be prohibitive. The mechanical equipment used to harvest stubble will not do a good job of picking up fallen ears of corn or shattered milo heads between rows. Thus, while the cow harvests less than the machine she may be more efficient in what she harvests.

Assuming that a decision has been made to graze cows on stubble, it should be remembered that stubble grazing is best suited to pregnant non-lactating cows. A cows requirement for energy goes up by 50 percent and protein requirements more than double when she calves. The data I am about to show will indicate how adequate stubble may or may not be for pregnant cows.

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*Research Director, Texas Tech University Center at Amarillo, Pantex, Texas 79069. Presented at the Annual Field Day, Texas Tech University Center at Amarillo, Pantex, March 11, 1976.

TABLE 1. (2)

Material	Crude protein	Total digestible nutrients	Calcium	Phosphorus
	Percent	Percent	Percent	Percent
Corn stover	4.2	59	.37	.12
Grain sorghum stover	4.7	57	.37	.12
Wheat straw	3.6	48	.17	.08

As shown in Table 1 the composition of corn and sorghum stubble are relatively equal. They are both fairly low in protein but a pregnant cows protein requirment is also low and will vary from 5.5 to 6.0 percent protein in her diet. Total digestible nutrients or TDN requirements are about 50 percent of the diet for a pregnant cow. Thus, stover will easily supply the energy needs and calcium needs of a mature cow and small amounts of supplemental protein and phosphorus will round out her diet.

The type and amount of supplemental protein has been studied extensively at the Iowa, Nebraska and Texas Tech Stations. Table 2 shows one such experiment conducted at the Nebraska station in the winter of 1971 - 1972. The data indicate some advantage in calf weaning weights due to added protein. The cows on soybean meal apparently built up their own body weight at the expense of their calves.

Table 3 shows an experiment conducted by Iowa State workers in which the type and amount of protein source were studied. While protein level did not affect weaning weights of calves, it did affect the rebreeding of the cows. The difference in rebreeding was also evident between urea and soybean meal. These data are not surprising in view of the large amount of research which shows that for optimum useage of urea, readily available starch energy sources must be available. The cellulose energy source of stubble thus does not lend itself to urea utilization.

In summary, pregnant non lactating cows can be wintered on corn or sorghum stubble for the last 100 to 120 days of pregnancy with about ½ pound of protein per head daily. Additional phosphorus should also be supplied in whatever supplement is fed. This supplement can be fed in either a dry or a liquid form depending on the facilities available. Using this type of inexpensive wintering program and a semiconfinement or pasture program throughout the balance of the year, the cow numbers can be greatly increased in the High Plains area. These increased numbers represent an increase in income for people currently in the farming business as well as a closer source of supply of calves for High Plains feedyards. As we have seen with so many other by-products; todays waste products are tomorrows high value feed.

TABLE 2. (3)

Variables	Corn (low protein)	Soybean meal	5% Urea	10% Urea
No. cows	10	10	10	10
Acres/cow	2.0	2.0	2.0	2.0
Protein intake lb.	0.09	0.40	0.40	0.44
Avg. wt. gain	82.8	108.8	78.4	90.0
205 day adj. calf wt.	494.7	491.1	501.6	503.5

TABLE 3.[4]

Variables	Low protein	Adequate protein	High protein urea	High protein soybean meal
% protein in diet	4.7	7.2	10.5	10.6
Cow wt. change	-115	-70	-67	- 1
130 day calve wt.	250	281	263	295
% cows bred at next season	50	83	50	83

(1) High Plains irrigation survey, 1972. Texas Agricultural Extension Service, College Station, Texas.

(2) Vetter, R. L., 1973. Nebraska Crop Residue Symposium.

(3) White, G., and Ward, J. K. Utilization and Supplementation of Crop Residues. 1974 Nebraska Beef Cattle Report, pp. 4-5.

(4) Vetter, R. L., and Weber, D. W. Urea vs Preformed Protein for Beef Cows Fed Crop Residue Rations.1974. Montana Nutrition Conference Proc. pp. 75-84.

THE VALUE OF A PERFORMANCE TESTED BULL

Robert A. Long*

What is the value of a performance tested bull? -- When asked this question one can only respond, "It beats me"!

Certainly this is a question of great importance to the entire beef industry. It concerns a purebred breeder as he selects a herd sire or prices the bulls he has for sale. It is of equal importance to the commercial breeder as he purchases semen or bulls. It is a major consideration - or should be - of the feeder as he evaluates the cattle with which he loads his feedlot. It is even of concern to packers as they procure slaughter cattle. Yet in spite of the importance of the question, the words "performance tested bull" mean nothing at all. Before one can give an intelligent answer he must in turn determine the following:

1. Performance tested for What?
2. Performance tested How?
3. Performance tested When?
4. Performance tested Where?
5. Performance tested With What?
6. What were the results?

Each of the previous questions deserves consideration but before undertaking that task let me ask the million dollar question. Why Performance Test? I can answer this question very simply. The answer is - <u>because it gets the job done; it works; it makes money; it improves herds; it improves breeds</u>. I firmly believe that if cattle are accurately performance tested for heritable traits of economic importance and the results used in a breeding program it will result in improved production and profit potential. You will actually improve the cattle genetically and if your nutrition, management and marketing are adequate you will make money.

Over forty years ago the first formal performance testing was conducted and reported. Two men working independently and half way across the country from each other decided to select replacement females and herd sires on the basis of how fast they increased in weight when compared to other cattle from the same herd, at the same age and under the same feeding and management. They both observed that "like begets like" and recorded that those cattle which grew fastest also produced calves that grew faster than those of their slower growing herdmates. This should not be surprising. Each of us has observed over and over again that animals tend to resemble their parents whether it be cattle, horses, dogs or people. I am certain that not a single person in the cattle business doubts that there is such a thing as heredity. Therefore, I cannot believe that a single person in the cattle business doubts the value of accurate performance testing. <u>The question then is not whether to performance test but rather how to performance test in order to get the right answer</u>.

As in all things,performance testing programs have gone through a developmental period and as new data was collected refinements have been added in an effort to include all the heritable factors which contribute to the efficient and profitable production of high quality beef. Progressive performance programs now measure not just gain but age at puberty, conception rate, calving ease, birth weight, efficiency of gain and composition of gain.

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Presented at the Annual Field Day, Texas Tech University Center at Amarillo, Pantex, Texas 79069, March 11, 1976.

RATE OF GAIN

There are those in the industry who believe that the only measure of importance is rate of gain and they suggest that a pair of scales is all anyone needs. Such thinking is responsible for procedures at some of the testing stations which, without regard for previous treatment, age, or weighing conditions, have stuffed empty cattle with feed in an effort to record the most possible increase in pounds per day.

What can happen at most test stations can be seen in Figure 1. Here a calf is born at 80 pounds and weaned at seven months weighing 600 pounds. During this period (A to B) from birth to weaning, both he and his mother may have been on an excellent plane of nutrition. At this point his breeder allows him to bawl for his mother and gives low quality hay for a ration so that during a period (B to C) of thirty days he loses 3.3 pounds per day and weighs 100 pounds less than at weaning and this could easily be an even greater loss in weight. He is then sent to the test station where he is given a 3 week "equalization" period. During this time he is given small amounts of feed to accustom him to a new ration, loses more weight in shipping, is handled frequently in sorting, weighing, vaccination, etc. and probably gains no more than 1.0 pound per day during this period from (C to D). His starting weight is now 530 pounds or 70 pounds less than his weaning weight approximately two months before. During the 140 day gain test (D to E) he is given a full feed of an excellent ration and so he makes a rapid increase in weight due to a combination of compensatory gain, fill and real growth. If his actual weight off test is 1050, he has gained 3.71 pounds per day for the 140 day test. However, this is very misleading since he actually weighed 600 pounds at weaning, therefore, he really has gained only 450 pounds over a 161 day period or 2.35 pounds per day. His adjusted 365 day weight is calculated to be 1180 but his actual weight is 1050 at 400 days. Such procedures cause new breeders to be disillusioned with buying performance tested cattle and results in old, established breeders failing to accept performance testing at all.

Of course, this situation would rank the cattle in the test properly if they were close to the same age and had all been treated exactly alike from birth to end of test, but this is not possible since they come from many different ranches with wide differences in pastures, creep rations, shrink and etc.

MATURE SIZE

Some cattlemen spend their time traveling around this country and others searching for a big bull. When they find one, they are not concerned with how long it took him to get that way or whether he is fat or lean, sound or unsound, but rather, is he big enough that they can claim a heavier bull than their neighbor. Size in itself is no claim to greatness.

LINEAR MEASUREMENTS

Some people carry tape measures, notched canes and I suspect even have a scale of inches tatooed on their chests. They attempt to measure every bull they see. Unfortunately, they compare measurements on bulls of different ages and management and have no standard methods of measurement. Further, they have no data which establishes what measurements are desirable. The irony of the whole measuring program is simply that this group assumes that the longer the better and the taller the better, but after all, no one has heard a housewife ask the butcher for a pound of "long" or been in a restaurant where some ordered a serving of "tall". A similar situation involves measurements for length of rump, back and neck. Such measurements are really a waste of time.

That part of total length represented by rump, back and neck are essentially the same for all cattle. The same is true of cannon bone length in proportion to height and etc. Leonardo da Vinci observed this fact in humans and horses 500 years ago. For example, he pointed out that in all humans their greatest reach from finger tip to finger tip is exactly their height regardless of whether they were considered short or tall, fat or lean. Therefore, the factors which determine value in cattle are not linear but rather gain per unit of feed consumed and

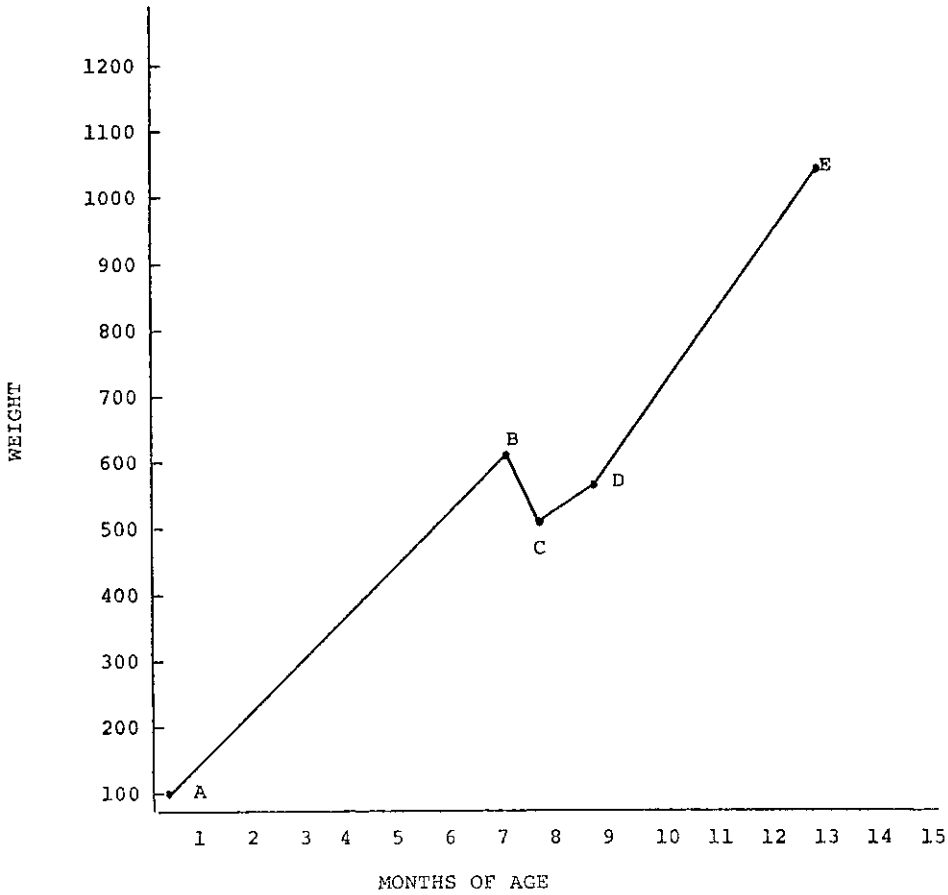

WEIGHT
1200
1100
1000
900
800
700
600
500
400
300
200
100
A
B
C
D
E
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
MONTHS OF AGE

Figure I

composition of that gain. This eliminates not only the people who measure their cattle but also the group that describe cattle by calling them types 1, 2, 3, 4 or 5. The number 1's are supposed to be short and stubby while the number 5's are long and tall. The problem here is that overall dimensions have nothing to do with composition. For example, one long and tall steer may be fat and wasty, and one of the same dimensions may be lean and heavily muscled. Remember, that portion of total length made up by either neck, back or rump is essentially the same in all cattle and all cattle of a certain length are about the same in height. We often allow differences in condition, sex, age and etc. to convince us otherwise but incorrectly so. If we select those cattle that grow fastest and convert their feed to lean, tender, juicy beef the type will take care of itself.

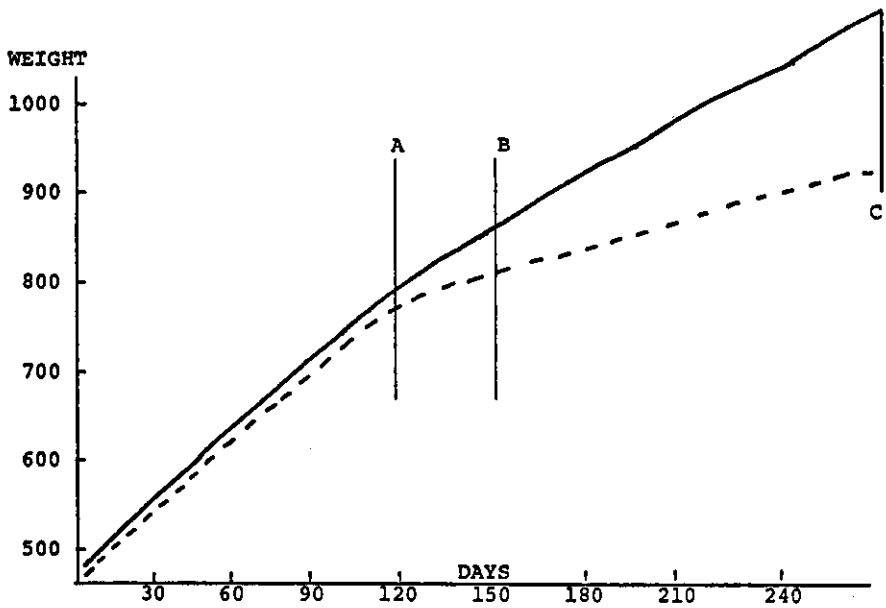
COMPOSITION OF GAIN

Still another program uses the "scan-o-gram" or ultrasonics to measure rib eye area and fat thickness at the twelfth rib as a measure of composition. Most claims for accuracy with this machine have been made by correlating the average scan-o-gram measurement of a group of cattle with the average actual measurement of that same group after slaughter. This fails to consider that herd bulls must be selected individually and not on the average. Also, a single measure of fat at the twelfth rib fails to consider variation in fat deposition patterns at other parts of the carcass. Finally, assuming that the scan-o-gram is 100% accurate (which it is not), the measurements taken with it are of no value unless they are made on cattle of the same age and sex, that have been treated alike.

Composition of gain is, of course, extremely important. There are tremendous differences between cattle going to slaughter in percent trimmed retail cuts or percent edible portion. These differences are of very sizeable dollar value and unfortunately the industry tends to pay feeders average values for their entire kill rather than compensate the producer of high cutability cattle or "dock" the producer of wasty, thin-muscled kinds. Fortunately, differences in composition can be identified in live cattle. Anyone can tell the difference between fat cattle and lean cattle or between heavily muscled cattle and thinly muscled ones. If you can't, you can be taught to do so in 5 minutes. If bulls are carrying much fat at the end of a 140 day gain test they should be culled. Everyone knows, that when fed alike bulls are leaner at a given age than steers and steers leaner than heifers. Therefore, if a bull off test is fat you know his steer and heifer progeny are going to be even fatter.

This raises the question of quality or marbling. In other words will high cutability cattle grade. Many people believe that cattle have to be wasty in order to marble. I cannot accept this. I believe that all cattle marble at a certain point and that this point is determined by genetic potential for maturity. Maturity is not a function of calendar age but rather of physiological age. Two steers, born on the same day and placed on the same ration at the same time, may gain in weight at the same rate for a period of time. Then one may continue to gain at this same rate and the other slow down in rate of gain. (See Figure II) That point at which steer #2 falls off in rate of gain is when he is approaching maturity. Not only is his gain reduced but he is depositing more fat in proportion to lean and his gain is less efficient because of the greater energy content of fat in comparison with muscle or lean. At this same stage of maturity, a steer also deposits fat or marbling between the muscle fibers and so he will grade at this time also. Therefore, the ideal time to slaughter steer #2 is at point B from the standpoint of efficiency and grade, but steer #1 should not be slaughtered until he reaches point C.

Cattle of the same age and on the same ration not only vary in amount of fat deposited but may deposit their fat entirely differently. For example, one steer may deposit fat in a uniform layer over the entire carcass and in an amount that may not be objectionable in retail cuts, hence, no trimming necessary. Another steer may leave the outside of the carcass almost entirely bare but deposit the same total amount of fat on the carcass unevenly with heavy layers at the loin edge, around the tail, in the flanks, brisket, internally on the kidneys and mesenteries or between the muscles as seam fat. For example, cattle with dairy



Steer #1 = _____ Steer #2 = _____

Figure II

blood which have been fed for slaughter usually show a thin layer of fat at the 12th rib and as a result are given a low yield grade indicating a high percentage of trimmed retail cuts. However, if the seam fat between the muscles, the fat deposited internally on the intestines, the kidney, heart and pelvic fat and that fat in their briskets and around their tail is taken into consideration they are not high cutability cattle.

We simply must select for leaner cattle. Each year more and more cattle are yield graded and packers cut, trim and box more beef. This means that there will be even more pressure on cutability. It means there will be a premium on cattle that convert feed to muscle not fat.

The opposite of fat is muscle. Muscle is the meat we eat. Therefore, any beef selection program must be seeking heavily muscled cattle. Whenever one mentions selection for muscle to cattle breeders someone always expresses fear for "double muscling". Obviously, "double muscling" or muscular hypertrophy is undesirable because it affects fertility and overall reproductive efficiency. However, if the gene for this trait is not in a herd or population you can select for muscle without any problem. If the gene is present and you select for muscle it soon comes to the surface and you can eliminate it. It simply makes no sense to select against muscle in a beef production program. The most important tissue in the carcass is obviously muscle. This is the beef we eat and this is the high quality protein so desired because of its nutritional benefits and its downright goodness.

COMPLETENESS OF PERFORMANCE RECORDS

Performance testing must not only be done accurately, but it must involve the entire herd and the cattle must be treated alike. Frankly, this statement tends to eliminate test stations where four or five bulls are consigned by many different breeders. A bull that does well in such a test station may be a good buy for someone needing more growth rate. However, the breeder of that bull has no way to compare him with the bulls he tested on his own ranch or the several groups of four or five bulls he consigned to various other test stations or to those he may not have tested at all. The breeder is using the test stations as a method of merchandising his bulls not as a method of testing them.

SUMMARY

Now let us go back to the original six questions.

1. Performance tested for What?

   There are only about three important factors to consider in evaluating beef breeding stock. They are:

   a. Reproductive efficiency.
   b. Increase in weight per unit of feed.
   c. Composition of that increase in weight.

   Therefore, you need to measure these traits and forget others.

2. Performance tested How?

   Cattle must be treated alike and compared at the same age.

3. Performance tested When?

   They should go on test as soon as they are born and stay on until they are at least a year old. There can be no interruption for showing or sales until they have completed yearling tests.

4. Performance tested Where?

   The cattle should be tested wherever you expect their offspring to perform. If their steer progeny will be fed in a feedlot then the bulls should be tested there and on the same kind of rations. They should be made to demonstrate their ability to fight their way up to the bunk and

eat a good ration without founder and without getting fat and wasty.

5. Performance tested with What?

   The cattle should be tested with all their herdmates. You can't decide which ones are the good ones until you have tested them.

6. What were the results of the test?

   Just the fact that the cattle have been performance tested means nothing. Were they found to be superior or not?

Performance tested bulls tested in this manner can improve your herd, your choice of breeds and your bank account.

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COMPOSITION, IN VITRO DIGESTIBILITY AND GAS PRODUCTION OF LOW GRADE CORN

C. B. Summers and L. B. Sherrod*

Summary

Studies were conducted to determine the effect of grade on the chemical composition, in vitro digestibility and in vitro gas production of No. 1 grade yellow corn, No. 5 grade yellow corn, and two sample grade (musty) yellow corns. Chemical composition was similar for all corn samples. Utilization was highest for No. 1 grade yellow corn and decreased with each lower grain quality.

Introduction

Poorly stored grain with high moisture content produces internal heat and provides an excellent medium for mold growth eventually resulting in changes in color and odor. This potential degradation could result in changes in composition and digestibility. Although not a large percentage of the total available grain, lower quality and/or damaged grain is offered for sale at reduced price to cattle feeders. Research information is limited concerning the nutritive value of lower quality and damaged grain. The present study was undertaken to determine the effect of quality grade on the composition, in vitro digestibility, and in vitro gas production of corn.

Procedure

Two groups of yellow corn apparently containing sufficient moisture to allow heat and mold damage were stored without preservative and with sufficient aeration to mold. Visual observation suggested that possible changes in composition and in vitro digestibility might have occurred. These corns were graded and then dried. Representative portions of a No. 1 grade yellow corn, a No. 5 grade yellow corn, and the two damaged corns were ground through a 1 mm screen for chemical analyses and in vitro digestibility determinations.

In vitro digestibility was determined according to the procedure previously described by Summers and Sherrod (1974). In vitro gas production (ml/hr/g DM) was determined by the procedure described by Hinders and Freeman (1969) as modified by Porter et al. (1973) to include adjustment to a standard grain.

Proximate analyses were conducted according to standard A.O.A.C. (1965) methods. Cell wall constituents content was determined by the methods described by Georing and Van Soest (1970). Cell soluble material was estimated by subtracting cell wall constituents (%) uncorrected for insoluble ash from 100. Estimated soluble carbohydrates content was calculated by subtracting % crude protein, % ether extract, % cell wall constituents, and % total ash from 100 (Harris, 1970).

Results and Discussion

Test weight, foreign matter or broken kernels, damaged kernels, and total damage are given in Table 1. Test weight was highest for No. 1 corn and sample

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TABLE 1. TEST WEIGHT, FOREIGN MATTER, HEAT DAMAGE AND TOTAL DAMAGE OF LOW GRADE CORN.

Grade	1	5	Sample A	Sample B
Test weight, lb/bushel	57.5	56.0	57.5	54.0
Foreign matter or broken kernels (%)	1.4	6.0	4.2	1.6
Damaged kernels (%)	0.0	0.0	1.7	11.5
Total damage (%)	0.0	0.0	22.0	59.2

grade A, somewhat lower for No. 5 corn, and lowest for sample grade B. Foreign matter or broken kernels content was greatest for No. 5 corn, followed by sample grade A, and then by No. 1 corn and sample grade B. Sample grade B was higher in damaged kernels and total damage than sample grade A. No. 1 and No. 5 corns did not contain any damaged kernels.

Composition, *in vitro* digestibility, and *in vitro* gas production are presented in Table 2. All four corns were similar in organic matter, ash, and crude protein content. Sample grade B was slightly higher in cell wall constituents and lower in cell soluble material than No. 1 and 5 corns, whereas sample grade A was slightly lower in cell wall constituents and higher in cell soluble material and estimated soluble carbohydrates than No. 1 and 5 corns. Ether extract content decreased with lower grain quality.

TABLE 2. CHEMICAL COMPOSITION, *IN VITRO* DIGESTIBILITY AND GAS PRODUCTION OF LOW GRADE CORN.

Sample	1	5	Sample A	Sample B
Dry matter, %	87.4	86.3	86.2	85.4
Composition, % of DM				
Organic matter	98.7	98.6	98.7	98.6
Ash	1.3	1.4	1.3	1.4
Cell walls[a]	10.1	10.4	9.4	11.8
Cell solubles	89.9	89.5	90.6	88.2
Crude protein	8.3	8.5	8.3	8.5
Ether extract	4.9	4.2	4.0	2.4
ESC[b]	75.4	75.5	77.0	75.9
In vitro				
Dry matter digestibility	95.3	93.0	91.7	90.8
Organic matter digestibility	95.4	92.9	91.7	90.8
Gas production, ml/hr/g DM	7.01	7.37	7.04	6.32

[a]Expressed on an ash free basis.

[b]Estimated soluble carbohydrates.

As indicated in Table 2, in vitro dry and organic matter digestibility was greatest for the No. 1 corn followed by No. 5 corn, then by sample grade A, and finally by sample grade B. In vitro digestibility decreased with each lower quality grade. In vitro gas production was highest for No. 5 corn, followed by No. 1 corn and sample grade A, and was lowest for sample grade B.

Molds may produce toxins causing an overall decrease in animal performance (Irving, 1971; Mirocha et al., 1971; and Fairbanks, 1940). Chemical preservatives, such as acetic and propionic acids, have generally elimated mold problems when properly applied to high moisture grains (Miller et al., 1972; Jones, 1970; Prigge et al., 1974; and Harpster et al., 1975).

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DIGESTIBILITY OF CORN BRAN RATIONS BY SHEEP

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Summary

Digestibility studies were conducted with sheep to determine the nutritive value of corn bran and corn bran plus corn screenings. Corn bran and corn bran with screenings were fed with a control ration containing 48.0 percent cottonseed hulls, 42.2 percent steamflaked sorghum grain in four ration treatments: (1) control ration, (2) 48.8 percent corn bran, 51.2 percent control ration (DM basis), (3) 48.3 percent corn bran, 0.5 percent corn screenings, 51.2 percent control ration, (4) 45.0 percent corn bran, 3.9 percent screenings and 51.1 percent control ration.

Corn bran was higher in fibrous components and crude protein, and lower in cell solubles and estimated soluble carbohydrates than a No. 1 grade yellow corn and corn screenings. No. 1 grade corn was somewhat higher in organic matter, cell solubles and ether extract, and somewhat lower in cell walls and ash content than corn screenings.

Dry and organic matter digestibility of the rations were similar for the control, corn bran and corn bran plus the lower level of screenings. The corn bran plus the higher level of corn screenings ration was slightly lower in dry and organic matter digestibility than the other three rations. Digestibility of the corn bran and corn bran plus screenings followed similar trends as the rations. Dry matter, organic matter and cellulose digestibility tended to decrease as level of corn screenings increased. Fiber digestibility decreased with the higher level of screenings. Results of this study indicate that corn bran and corn screenings have acceptable levels of digestible energy and protein per unit of dry matter and can be feasibly used as ingredients in ruminant rations.

Introduction

By-products of agricultural industries have provided several important ingredients for ruminant rations. These by-products may come directly from agricultural production such as field residues, or from further processing such as beet pulp and the various oil meals. Corn bran, the hull or seed coat of the kernel, and corn screenings, the misshapen or broken kernels and foreign matter, are by-products of the wet milling extraction of corn starch. Both bran and screenings are available for use as livestock feed. Research information is limited concerning the nutritive value of corn bran and screenings in ruminant rations. Therefore, this study was conducted to determine the digestibility of corn bran and corn bran plus corn screenings.

Procedure

Corn bran (30.6 % DM) was obtained weekly on the day of production and stored in polyethylene bags until use. Corn screenings were obtained at the beginning

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of the study and stored in drums. Corn bran, screenings and a control ration containing 48 percent cottonseed hulls and 42 percent steamflaked sorghum grain were used in four ration treatments. Ingredient content of these rations is given in Table 1.

Crossbred wethers averaging 40.8 kg were used in two digestibility trials involving 14 day preliminary and 5 day collection periods. The animals were randomly allotted for a total of 6 animals per treatment, with the restriction that no sheep would receive identical treatments during successive trials. Rations were fed twice daily with feed intake levels held as nearly constant as possible in both trials. Water was available free choice. Ration ingredients were sampled at each feeding beginning two days prior to the first day of collection. Total wet feces were weighed, sampled (10 % aliquot), and the samples composited daily. Fecal samples were frozen until analyzed.

Proximate analyses of ration ingredients and feces were conducted by standard A.O.A.C. (1965) methods. Cell walls and acid detergent fiber were determined by the method described by Goering and Van Soest (1970). Cellulose and acid-detergent lignin were determined by the Fonnesbeck and Harris (1970) modification of the Goering and Van Soest (1970) procedure. Cell solubles were estimated by subtracting the cell walls (%) uncorrected for insoluble ash from 100. Estimated soluble carbohydrates were calculated by subtracting crude protein (%), ether extract (%), cell walls (%) and total ash (%) from 100 (Harris, 1970). Gross energy was determined with an oxygen bomb, adiabatic calorimeter. True protein digestibility was calculated using the value of 0.45 g metabolic fecal nitrogen per 100 g dry matter intake (Blaxter, 1964). Digestibility of corn bran and corn bran plus corn screenings was calculated by difference using determined values for the control ration and data for the complete corn bran rations. Total digestible nutrients were determined using the digestible organic matter method (Lofgreen, 1953).

Results and Discussion

Dry matter content and chemical composition of the four rations are given in Table 2. The control ration was considerably higher in dry matter, ash, acid detergent fiber, lignin, cell solubles and estimated soluble carbohydrates, somewhat higher in cellulose, and somewhat lower in organic matter, cell walls, ether extract and gross energy than any of the rations containing corn bran. Corn bran rations were comparable in organic matter, ash, acid detergent fiber, cellulose, lignin, ether extract and gross energy content. The corn bran ration containing the higher level of screenings (CBS-R B) was slightly lower in cell walls content and slightly higher in cell solubles and estimated soluble carbohydrates than the other corn bran rations. Crude protein content was the same for all four rations.

Dry matter content and composition of No. 1 grade yellow corn, corn bran and corn screenings are given in Table 3. Corn bran was much higher in fibrous components and much lower in cell solubles and estimated soluble carbohydrates than corn and corn screenings. Corn bran was somewhat higher in crude protein content than corn and corn screenings. Ether extract was greatest for corn, followed by corn bran and then by corn screenings. Results indicate that corn bran was considerably higher in fibrous nutrients, somewhat higher in crude protein, and much lower in soluble nutrients than corn, and are consistent with those reported by Sherrod (1972). Since the purpose of wet milling extraction is corn starch production, a large increase in fibrous components and corresponding decrease in soluble nutrients is expected. No. 1 grade corn was somewhat higher in organic matter, cell solubles and ether extract, and lower in cell walls and ash content than corn screenings.

Digestibility coefficients for control, corn bran and corn bran plus screenings rations are presented in Table 4. Dry and organic matter digestibility were similar for the control, corn bran and corn bran plus a lower level of screenings (CBS-R A) rations. CBS-R B was slightly lower in dry and organic matter digestibility than the other three rations. Cell walls and acid detergent fiber digest-

ibility was greatest for the corn bran and CBS-R A rations, followed by the CBS-R B, and finally by the control ration. Cellulose digestibility was similar for the control, corn bran and CBS-R A, and somewhat lower for the CBS-R B ration. The control ration was highest in cell solubles digestibility, followed by CBS-R B, and then by the corn bran and CBS-R A rations. Crude protein digestibility, both apparent and true, was highest for the corn bran and CBS-R B rations, somewhat lower for the CBS-R A and lowest for the control. Ether extract digestibility was greatest for the control, followed by the CBS-R B and then by the corn bran and CBS-R A rations. Estimated soluble carbohydrates digestibility was highest for the control and CBS-R B, and somewhat less for the corn bran and CBS-R A. Gross energy digestibility and digestible energy were similar for all four rations. TDN was greatest for the corn bran and CBS-R A, slightly less for the control, and lowest for the CBS-R B.

Digestibility of corn bran and corn bran plus two levels of corn screenings calculated by difference is given in Table 5. Dry matter, organic matter, and cellulose digestibility tended to decrease as level of corn screenings increased. Corn bran and corn bran plus the lower level of screenings (CBS A) were considerably higher in cell walls, acid detergent fiber, and cellulose digestibility than corn bran plus the higher level of screenings (CBS B). Fiber digestibility decreased with the higher level of corn screenings. Fontenot et al., (1955), Dowe et al., (1955), Campbell et al., (1969), Sherrod and Ishizaki (1968), Mitchell et al., (1940), Hamilton (1942), and Swift et al., (1947) found that fiber digestibility was depressed when soluble carbohydrates content was increased. CBS B was higher in cell solubles, ether extract, and estimated soluble carbohydrates digestibility than corn bran and CBS A. Crude protein digestibility, both apparent and true, was higher for corn bran and CBS B than for CBS A. Gross energy digestibility and digestible energy were similar for corn bran and corn bran plus two levels of screenings. TDN tended to decrease as level of corn screenings increased.

Data from this study indicate that corn bran and corn screenings have acceptable levels of digestible energy and protein per unit of dry matter and can be feasibly used as ingredients in ruminant rations. Summers and Sherrod (1975) found that a growing ration containing corn bran was more efficient in feed conversion than similar rations containing cottonseed hulls or corn silage when compared on a constant dry matter basis. Other results indicated that feed conversion by finishing steers was not affected when corn bran replaced up to 60 percent of the sorghum grain in the ration on an equivalent dry matter basis.

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Table 1. Ingredient Composition of Control, Corn Bran and Corn Bran Plus Corn Screenings Rations Used in Digestibility Trial.

	Control	Corn bran	Corn bran + screenings A	Corn bran + screenings B
Composition, % of dry matter				
Corn bran	----	48.8	48.3	45.0
Corn screenings	----	----	0.5	3.9
Cottonseed hulls	48.0	24.5	24.5	24.4
Steamflaked sorghum grain	42.2	21.5	21.5	21.5
Premix	5.9	3.0	3.0	3.0
Cottonseed meal	3.9	2.0	2.0	2.0
Salt	----	0.2	0.2	0.2

Table 2. Chemical Composition of Control, Corn Bran and Corn Bran Plus Corn Screenings Rations Used in Digestibility Trial.

Ration	Control	Corn bran[a]	Corn bran[b] + screenings A	Corn bran[c] + screenings B
Ration % dry matter	86.0	44.2	46.0	44.4
Ration composition, % of DM				
Organic matter	95.7	97.2	97.2	97.2
Ash	4.3	2.8	2.8	2.8
Cell wall constituents[d]	43.7	56.6	56.4	54.5
Acid detergent fiber	34.5	26.9	26.8	26.3
Cellulose	24.2	21.2	21.2	20.6
Lignin	10.4	5.8	5.8	5.8
Cell soluble material	54.4	41.4	41.7	43.6
Crude protein	9.9	9.9	9.9	9.9
Ether extract	2.3	2.7	2.7	2.7
ESC[e]	39.8	28.0	28.2	30.2
Gross energy, kcal/g DM	4.364	4.447	4.447	4.441

[a]Ration contained 48.8% corn bran on dry matter basis.

[b]Ration contained 48.3% corn bran and 0.5% corn screenings on a dry matter basis.

[c]Ration contained 45.0% corn bran and 3.9% corn screenings on a dry matter basis.

[d]All fiber values are expressed on an ash free basis.

[e]Estimated soluble carbohydrates.

TABLE 3. CHEMICAL COMPOSITION OF CORN, CORN BRAN AND CORN SCREENINGS

Sample	Corn	Corn bran	Corn screenings
Dry matter, %	87.4	30.6	87.5
Composition, % of DM			
Organic matter	98.7	99.3	98.0
Ash	1.3	0.7	2.0
Cell wall constituents[a]	10.1	70.4	12.5
Acid detergent fiber	----	19.1	4.6
Cellulose	----	18.0	3.7
Lignin	----	1.0	0.9
Cell soluble material	89.9	28.0	86.9
Crude protein	8.3	10.0	8.3
Ether extract	4.9	3.1	2.8
ESC[b]	75.4	15.8	74.4
Gross energy, kcal/g DM	----	4.547	4.444

[a]All fiber values are expressed on an ash free basis.

[b]Estimated soluble carbohydrates.

Table 4. Digestibility of Control, Corn Bran, and Corn Bran Plus Corn Screenings Rations.

Ration	Control	Corn bran[a]	Corn bran[b] + screenings A	Corn bran[c] + screenings B
Daily DM intake, g	919.0	896.7	872.1	885.9
Digestibility, %				
Dry matter	64.5	64.6	64.2	62.8
Organic matter	65.2	65.4	65.1	63.7
Cell wall constituents	52.4	59.6	59.4	54.2
Acid detergent fiber	35.6	41.8	41.8	39.0
Cellulose	57.9	58.8	57.7	54.4
Cell soluble material	76.0	72.6	72.0	74.8
Crude protein, apparent	36.3	47.6	45.0	46.9
Crude protein, true	64.5	75.9	73.4	75.4
Ether extract	86.6	76.0	75.9	78.3
ESC[d]	85.5	82.5	82.2	84.8
Gross energy	62.9	62.8	62.9	62.5
Digest. energy, kcal/g DM	2.74	2.79	2.80	2.78
TDN, DM basis, %[e]	62.4	63.6	63.3	61.9

[a]Ration contained 48.8% corn bran on a dry matter basis.

[b]Ration contained 48.3% corn bran and 0.5% corn screenings on a dry matter basis.

[c]Ration contained 45.0% corn bran and 3.9% corn screenings on a dry matter basis.

[d]Estimated soluble carbohydrates.

[e]Calculated using the digestible organic matter method (Lofgreen, 1953).

Table 5. Digestibility of Corn Bran and Corn Bran Plus Corn Screenings Calculated by Difference.

Sample	Corn bran	Corn bran[a] + screenings A	Corn bran[b] + screenings B
Digestibility, %			
Dry matter	64.8	63.9	61.0
Organic matter	65.7	65.0	62.0
Cell wall constituents	64.4	64.2	55.2
Acid detergent fiber	53.7	53.5	45.6
Cellulose	60.2	57.6	48.8
Cell soluble material	65.5	64.0	72.7
Crude protein, apparent	58.7	53.5	57.5
Crude protein, true	87.0	81.9	86.1
Ether extract	68.0	67.7	71.9
ESC[c]	74.5	74.0	83.4
Gross energy	62.7	62.9	62.2
Digest. energy, kcal/g DM	2.85	2.86	2.82
TDN, DM basis, %[d]	65.2	64.5	61.5

[a]99.0% corn bran and 1.0% corn screenings on a dry matter basis.

[b]92.1% corn bran and 7.9% corn screenings on a dry matter basis.

[c]Estimated soluble carbohydrates.

[d]Calculated using the digestible organic matter method (Lofgreen, 1953).

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NUTRITIONAL EVALUATION OF GREENBUG RESISTANT SORGHUM

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Summary

Chemical composition and in vitro digestibility results indicate that the greenbug resistant characteristic of sorghum generally did not affect nutritive value of the grain, leaves or stalks when resistant sorghums were compared to non-resistant sorghums.

Introduction

Recent genetic discoveries in sorghum breeding have resulted in sorghums which are resistant to the attack of greenbugs. Information is needed to evaluate the influence of this characteristic upon nutritive value of these sorghums. Therefore, this project was conducted:

1) to determine the comparative nutrient and energy value of greenbug resistant and non-resistant sorghum grain and stover.

2) to determine the percentages of cell wall constituents (cellulose, hemicellulose and lignin), cell soluble materials, and soluble carbohydrates in greenbug resistant and non-resistant sorghum.

3) to determine the in vitro dry matter and organic matter digestibilities of greenbug resistant and non-resistant sorghum.

Experimental Procedure

Samples of greenbug resistant and non-resistant sorghum stover from 4 geographical locations were obtained and analyzed using the following laboratory procedures. Locations included Clay Center, Nebraska, New Deal, Texas, Lubbock, Texas and Stinnett, Texas with the latter location sampled after frost and involving two hybrids. The New Deal location had the most insect damage with an estimate of five functional leaves lost from susceptible hybrid and two from the resistant. Three hybrids, C-42Y, E-59 and F-67 were evaluated. Grain from one variety (C-42Y) at one location (Lubbock) was also evaluated. Samples of leaves and stalks from 5 plants of each variety were ground and composited for chemical analyses.

Objective 1. The methods of A.O.A.C. (1965) were used to determine crude protein, ether extract, ash and dry matter. Gross energy was determined using a Parr, adiabatic bomb calorimeter.

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Objective 2. Cell wall constituents and acid detergent fiber were determined by the methods described by Goering and Van Soest (1970). Acid detergent lignin and cellulose were determined by the Fonnesbeck and Harris (1970) modification of the Goering and Van Soest (1970) procedure. Hemicellulose content was the difference between cell wall constituents and acid detergent fiber. Cell soluble material was estimated by subtracting the cell wall constituent value (%) uncorrected for insoluble ash from 100. Estimated soluble carbohydrate content was calculated by subtracting crude protein (%), ether extract (%), cell wall constituents (%) and total ash (%) from 100 (Harris, 1970).

Objective 3. In vitro dry matter and organic matter digestibilities were determined by the Moore modification of the two-stage Tilley-Terry procedure as given by Harris (1970) which was further modified by using 2.0 g (air-dry) samples and 100 ml rumen fluid: buffer solution (30:70) inoculum in 250 ml centrifuge bottles (Sherrod and Summers, 1974).

Results and Discussion

Data obtained from this study are presented in Tables 1, 2 and 3. Table 1 gives the chemical composition and in vitro digestibility of sorghum stubble leaves; Table 2 portrays data for sorghum stubble stems; and Table 3 provides values for sorghum grain. Tables 4, 5 and 6 present means for susceptible and resistant sorghum. All data were subjected to analysis of variance. No significant ($P>.05$) differences were detected between susceptible and resistant comparisons. In vitro digestibility means of four comparisons in Table 4 indicate that resistant leaves were favored for both dry matter and organic matter. Conversely stalks of the susceptible plants were slightly more digestible. This difference was most obvious where damage was heaviest (New Deal E-59 samples, Tables 1 and 2) which suggests heavy insect damage could adversely affect leaf feed value. In addition, the damaged leaves may be translocating nutrients into the stalks which could account for higher stem value. This might be a compensatory effect because of reduced photosynthetic area of the leaves.

These data indicate that generally no differences would be expected for chemical components and digestibility values between susceptible and resistant sorghums.

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Table 1. Chemical Composition and *In Vitro* Digestibility of Different Grain Sorghum Stubble Leaves

Item	Varieties:	G42Y[c]	G42Y[d]	E-59[c]	E-59[d]	C-42Y[c]	C-42Y[d]	E-59[c]	E-59[d]	E-59[d]
	Location:	Clay Center, Nebr.		New Deal, Texas		Lubbock, Texas		Stinnett, Texas		
Composition, % of DM										
Organic Matter		84.0	82.4	73.6	75.2	83.4	82.5	81.6	82.8	80.4
Ash		16.0	17.6	26.4	24.8	16.6	17.5	18.4	17.2	19.6
Cell walls[a]		59.1	58.2	47.6	48.3	53.8	53.2	52.9	53.3	52.1
Acid detergent fiber		33.7	33.6	28.2	27.7	30.0	29.7	31.0	30.4	28.9
Cellulose		29.0	28.8	22.6	23.3	25.5	25.5	26.2	26.2	24.0
Lignin		4.7	4.8	5.6	4.4	4.6	4.2	4.8	4.2	4.9
Hemicellulose		25.4	24.6	19.4	20.6	23.8	23.5	21.9	22.9	23.2
Cell solubles		32.0	31.7	30.3	34.7	36.9	37.1	36.5	37.6	36.6
Crude protein		13.5	14.1	10.5	11.3	10.8	12.0	8.1	8.8	9.6
Ether extract		2.5	2.5	1.4	2.1	2.9	2.9	2.0	1.8	1.8
ESC[b]		8.9	7.6	14.1	13.5	15.9	14.4	18.6	18.9	16.9
Gross energy, Kcal/g DM		3.844	3.748	3.487	3.594	3.691	3.567	3.452	3.754	3.661
In vitro digestibility, %										
Dry matter		58.3	57.0	42.7	49.4	58.5	58.4	56.6	59.0	56.2
Organic matter		63.4	62.8	54.4	60.9	64.3	64.1	63.1	64.6	63.1

[a]All fiber values are expressed on an ash-free basis.

[b]Estimated soluble carbohydrates.

[c]Susceptible to greenbug attack.

[d]Resistant to greenbug attack.

Table 2. Chemical Composition and *In Vitro* Digestibility of Different Grain Sorghum Stubble Stems

Item / Varieties:	C-42Y[d]	C-42Y[e]	E-59[d]	E-59[e]	C-42Y[d]	C-42Y[e]	F-67[d]	F-67[e]	E-59[d]	E-59[e]	E-59[e]
Location:	Clay Center, Nebr.		New Deal, Texas		Lubbock, Texas		Stinnett, Texas		Stinnett, Texas		
Composition, % of DM											
Organic matter	87.7	88.4	89.6	89.4	89.2	88.9	90.8	90.5	91.4	91.4	90.9
Ash	12.3	11.6	10.4	10.6	10.8	11.1	9.2	9.5	8.6	8.6	9.1
Cell walls[a]	71.8	72.6	69.9	68.5	66.5	67.8	61.7	65.4	60.9	59.4	60.9
Acid deter. fiber	48.4	49.3	46.1	43.1	42.4	42.2	38.8	41.4	38.3	38.0	38.2
Cellulose	42.3	43.2	40.2	37.3	36.3	36.6	32.5	35.1	32.5	32.0	32.8
Lignin	6.0	6.1	5.9	5.8	6.1	5.5	6.2	6.3	5.8	5.9	5.4
Hemicellulose	23.4	23.3	23.8	25.4	24.1	25.6	22.9	24.0	22.6	21.4	22.7
Cell solubles	26.2	25.4	28.2	29.7	31.9	31.0	35.6	32.4	37.6	38.8	37.2
Crude protein	3.1	4.1	4.9	3.9	3.9	3.4	4.4	4.1	3.8	4.7	3.9
Ether extract	0.6	0.3	0.8	0.7	0.4	0.5	0.6	1.0	0.3	0.5	0.4
ESC[b]	12.2	11.4	14.0	16.3	18.4	17.2	24.1	20.0	26.4	26.8	25.7
Gross energy[c]	4.08	3.92	4.03	4.05	3.81	4.02	4.11	3.95	3.97	4.05	4.16
In vitro digest, %											
Dry matter	54.8	55.6	52.3	50.4	48.4	48.3	54.8	51.5	55.6	55.8	56.8
Organic matter	52.6	53.9	50.7	48.0	45.9	45.2	55.1	50.7	55.5	55.8	56.8

[a]All fiber values are expressed on an ash-free basis.

[b]Estimated soluble carbohydrates.

[c]Kcal/g DM.

[d]Susceptible to greenbug attack.

[e]Resistant to greenbug attack.

Table 3. Chemical Composition and *In Vitro* Digestibility of Different Sorghum Grain Seeds

Item	Varieties:	C-42Y[c]	C-42Y[d]
	Location:	Lubbock, Texas	
Composition, % of DM			
Organic matter		96.6	97.7
Ash		3.4	2.3
Cell walls[a]		12.7	10.2
Cell solubles		87.1	89.7
Crude protein		11.3	11.2
Ether extract		5.5	3.8
ESC[b]		67.1	72.5
Gross energy, kcal/g DM		4.373	4.389
In vitro digestibility, %			
Dry matter		87.4	87.7
Organic matter		87.6	87.8

[a]Expressed on an ash-free basis.

[b]Estimated soluble carbohydrates.

[c]Susceptible to greenbug attack.

[d]Resistant to greenbug attack.

Table 4. Mean digestibility percentages for greenbug resistant and susceptible hybrid sorghum stover

	In vitro digestibility, %	
	Resistant	Susceptible
Dry matter		
stover leaves[a]	55.6	54.0
stover stems[b]	52.4	53.2
Organic matter		
stover leaves[a]	62.9	61.3
stover stems[b]	50.8	52.0

[a]Mean of four comparisons

[b]Mean of five comparisons

Table 5. Composition of greenbug resistant and susceptible hybrid sorghum leaves - four comparisons

	Composition, % of D. M.	
Leaf analysis	Resistant	Susceptible
Cell walls	53.1	53.4
lignin	4.6	4.9
Cell solubles	35.2	33.9
crude protein	11.6	10.7
ESC[a]	13.4	14.4

[a]Estimated soluble carbohydrates

Table 6. Composition of greenbug resistant and susceptible hybrid sorghum stems - five comparisons

	Composition, % of D. M.	
Stem analysis	Resistant	Susceptible
Cell walls	66.9	66.2
lignin	5.9	6.0
Cell solubles	31.3	31.9
crude protein	4.0	4.0
ESC[a]	18.2	19.0

[a]Estimated soluble carbohydrates

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NUTRITIONAL EVALUATION OF LIGHT WEIGHT AND SMALL SEED SORGHUM

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Summary

Sorghum grain of different bushel weights were obtained from Northern Kansas, the Oklahoma Panhandle, the Texas Panhandle and the Texas High Plains. Each sample was processed by dry-rolling and by steam-pressure flaking. Samples of sorghum were separated into small, medium and large seed sizes, processed and prepared for laboratory analyses in the same manner as for sorghum of different bushel weights.

Lower values ($P<.01$) were detected for starch availability and gelatinization of steam-pressure flaked sorghum weighing under 40 lb/bu as compared to sorghum weighing over 40 lb/bu. No differences ($P>.05$) were detected for % crude protein among sorghum samples of different bushel weights. No nutritional differences were detected among samples of sorghum weighing above 40 lb/bu. A negative correlation ($r= -.87$; $P<.05$) was detected between bushel weight and crude fiber; % crude fiber increased as bushel weight decreased. Sorghum with small size seed contained a lower ($P<.01$) % crude protein and a lighter ($P<.10$) bushel weight than sorghum of large size seed. Whole sorghum of small size seed would be expected to comprise a small percentage, approximately 7% or less, of the total amount of any given sample of sorghum grain.

Gas production determined on a per g of starch basis was highly correlated with gas production determined on a per g of dry matter basis ($r=.99$; $P<.01$). Therefore, both techniques estimate starch availability in grains.

Introduction

Sorghum is a major grain source for feeding cattle and sheep in the Southwestern United States. Sorghum that has been stressed during seed development may result in light weight grain testing below 54 lb/bu. The occurrence of small seed within harvested grain has become more pronounced within the past few years. Possible nutritional differences as well as processing and flaking difficulties have been attributed to both light weight and small seed sorghum.

During recent years, steam flaking has been the predominant method of processing sorghum in Southwestern commercial feedlots (Croka and Wagner, 1975). The effect of method of processing upon the solubility of the protein matrix which encapsulate starch granules in the endosperm seems to be the major factor affecting efficiency of utilization. Steam-flaking of sorghum grain for cattle has consistently shown improvement in energy utilization over conventional grinding. Therefore, processing methods which produce a change in the organization of the sorghum grain to release starch granules from the protein matrix offer promise of increasing energy utilization.

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The purpose of this study was to determine the nutritional characteristics of sorghum of different bushel weights and seed size and the effect of processing on these sorghums.

Experimental Procedure

Each grain sample was processed by a laboratory scale model steam-pressure flaking technique developed by Sherrod and Summers (Texas Tech University Center at Amarillo, Pantex, unpublished). One-hundred g of each grain sample were weighed in duplicate, placed in a cheesecloth bag, and soaked for 2 min in hot tap water. The grain was steamed at 15 lb pressure for approximately 30 min and then allowed to cool for .5 to 1 min, followed by flaking through 4 in x 10 in grooved roolers. Steam-pressured grain was dropped by hand through the rollers at a slow, constant rate to insure flaking of each grain. The flaked grain was then transferred to a graduated cylinder with which the depth of grain in cc was recorded and the wet weight of the flaked grain obtained. The processed grain was allowed to dry for approximately 24 hr at 100° C. Only whole, cleaned sorghum was processed. Dry-ground samples and flaked samples were ground through a Wiley Mill with a 20 mesh screen.

Samples of sorghum were separated into small, medium and large seed size of 2.83 mm and 3.36 mm. Large, medium and small seed sizes were greater than 3.36 mm, 2.83 to 3.36 mm and less than 2.83 mm, respectively. The different sizes of seed were processed and prepared for laboratory analyses in the same manner as for sorghum of different bushel weights. Bushel weights of the sorghum samples were verified by dividing the weight of 100 cc of seed from each sample by the weight of 100 seeds. Availability of starch in the dry ground and processed grains was determined as susceptibility to Diazyme 160, a powdered beta-amyloglucosidase enzyme as described by Hinders and Freeman (1969) and Porter et al., (1973). Starch gelatinization by enzyme digestion was determined by measuring mg maltose produced per g of sample, as described by Ralston-Purina Research 900 Technique (1972). This technique was modified in that all quantities were 20% of those described and the incubation time used in this study was 3 hr instead of 4 hr. Grain samples were analyzed for dry matter, ash, ether extract, crude protein, and crude fiber using standard procedures (A.O.A.C., 1970). Gross energy determinations were performed with a Parr oxygen bomb, adiabatic calorimeter.

Analysis of variance was conducted to determine significant differences for parameters measured among the sorghum samples varying in bushel weight and seed size. Simple correlation coefficients were determined between all the parameters.

Results and Discussion

Simple correlation coefficients were determined between all parameters (Table 1), using each nutritional or energy variable as X with each of the other variables as Y. Significant correlations were detected between bushel weight and % crude fiber ($P<.01$) and with all detergent fiber fractions, except % lignin. Crude fiber percentage was determined to be highly correlated to % cell wall constituents and % lignin. Steam-pressure flaked gas production was highly correlated with degree of gelatinization ($P<.01$). Degree of gelatinization was highly correlated ($P<.05$) with both % cell wall constituents and % hemicellulose. Percentage cell wall constituents was highly correlated ($P<.05$) with % hemicellulose and % acid detergent fiber. Cellulose percentage was determined to be highly correlated to % lignin and % acid detergent fiber ($P<.01$). No significant correlations ($P<.05$) were detected between bushel weight and % crude protein, % ether extract, gross energy (kcal/g) and % ash.

The effect of bushel weight upon the nutritional value of steam-pressure flaked sorghum is summarized in Table 2. Lower values ($P<.01$) were detected for starch availability and gelatinization of steam-pressure flaked sorghum weighing under 40 lb/bu versus sorghum weighing above 40 lb/bu. Percent dry matter for steam-pressure flaked sorghum weighing below 40 lb/bu was lower ($P<.005$) than that of sorghum weighing above 40 lb/bu. Higher values were detected for acid

TABLE 1

CORRELATION COEFFICIENTS FOR ALL PARAMETERS MEASURED AMONG SORGHUM SAMPLES OF DIFFERENT BUSHEL WEIGHTS

	Crude Fiber	Gas	Gelatin-ization	Gross Energy	Cell Wall Constituents	Cellu-lose	Lignin	Hemi-cellulose	Acid Detergent Fiber
Bushel Weight[a]	-.87**[b]	.26	.64	--	-.85*	-.84*	-.69	-.77*	-.86*
Crude Fiber[c]		-.39	-.35	.42	.91**	.86*	.51	.87**	-.42
Gas[a]			.85*	-.46	-.88**	-.61	-.40	-.94**	-.59
Gelatin-ization[a]				-.01	-.96**	-.72	-.49	-.97**	-.73
Gross Energy[a]					-.005	-.33	-.32	-.17	-.36
Cell Wall Constituents[a]						.87**	.61	.97**	.87**
Cellulose[a]							.75*	.72	.99**
Lignin[a]								.45	.58
Hemi-cellulose[a]									

[a] N + 6

[b] N + 14

[c] N + 4

*P<.05

**P<.01

TABLE 2 : EFFECT OF BUSHEL WEIGHT UPON VARIOUS NUTRITIONAL PARAMETERS OF STEAM-PRESSURE FLAKED SORGHUM

Number of Samples	Bushel Weight, lb	Dry Matter %	Crude Protein %	Starch Availability[a]	Gelatinization (mg maltose/g)	Gross Energy (kcal/g)	Crude Fiber %	Acid Detergent Fiber
9	30, 37	62.80±2.76[b, c]	11.5±3.00	10.8±1.5[d]	271±63[d]	4.405	3.21	11.9
20	45, 48	72.08±4.50	12.5±1.12	19.3±3.2	428±74	4.423	2.88	9.1
41	50	75.58±1.59	11.1±1.47	20.8±5.5	451±64	4.381	2.75	8.9
39	52	73.85±4.35	10.8± .87	19.3±3.2	417±75	4.353	2.47	6.1
34	54	77.67±3.28	10.3± .41	19.7±3.3	445±67	4.380	2.13	8.3
38	56, 58, 60	76.00±2.36	11.0±1.10	18.2±3.0	422±82	4.364	1.82	

[a]Estimated as ml gas produced/hr/g of grain dry matter.

[b]Standard deviation.

[c]Significantly lower (P<.005) from the other parameters for bushel weights.

[d]Significantly lower (P<.01) from the other parameters for bushel weights.

[e]Each value represents one sample.

detergent fiber of sorghum weighing under 40 lb/bu versus sorghum testing over 40 lb/bu.

The effect of bushel weight upon the nutritional value of dry-ground sorghum is summarized in Table 3. No significant differences ($P>.05$) were detected among the sorghum samples varying in bushel weight, although gas production was lower for bushel weights under 40 lb.

TABLE 3. EFFECT OF BUSHEL WEIGHT UPON VARIOUS NUTRITIONAL PARAMETERS OF DRY-GROUND SORGHUM

Number of samples	Bushel weight, lb	Dry matter %	Crude protein %	Starch availability[a]	Gelatinization (mg maltose/g)
9	30, 37	85.6	11.5	4.9	58.7
20	45, 48	87.5	12.6	5.6	59.2
41	50	85.8	11.0	5.6	57.6
39	52	87.1	10.5	5.6	58.6
34	54	87.1	10.4	6.2	57.5
38	56, 58, 60	88.2	10.8	6.0	59.5

[a]Estimated as ml gas produced /hr/g of grain dry matter.

The data reported herein suggest that fiber could be involved in reducing starch availability. Gas production and gelatinization values were lowest for sorghum having the highest fiber levels (less than 40 lb/bu) with both unprocessed and processed samples. In addition, less improvement in gas production and gelatinization occurred with flaking for the grains weighing less than 40 lb/bu when compared to those weighing above 40 lb/bu. However, steam flaking increased starch availability and gelatinization in all samples of sorghum which agrees with other results (Buchanan-Smith et al., 1968; Croka and Wagner, 1975; McNeill et al., 1975; Liang et al., 1970; Osman et al., 1970; Trei et al., 1966 and 1970).

Attempts were made to carefully standardize and maintain processing technique in this study and an effort was made to insure that each steam-pressure processed seed was flaked. However, the light weight sorghum weighing under 40 lb/bu had a different texture during flaking, resulting in a gummy, sticky flake that tended to attach to the grooved rolls of the flaking mill. There might be less nutritional difference in light weight sorghum with constant processing; however proper processing appears more difficult with low test weight sorghums. Decreases in efficiency of utilization observed with light weight and/or sorghum of small seed size under feedlot conditions might be associated with degree of processing. In addition, the higher fiber levels in sorghum weighing less than 40 lb/bu may influence utilization of the light weight sorghum.

The effects of small or large seed size upon the nutritional value of sorghum is presented in Table 4. Small size seed tended to weigh less per bushel than large seed ($P<.10$). Small seed contained a lower % crude protein than large seed ($P<.01$). No significant correlations were detected for starch availability and degree of gelatinization between small and large seed sizes.

Seed from one sample of sorghum was screened into different seed sizes using 2.80 mm and 3.36 mm sieves. Only 7.3% of the total seed was small seed, whereas medium and large size seed constituted a majority of the mixture (44.4% and 40.9%, respectively). A significant correlation was determined between steam-pressure flaked gas production versus degree of gelatinization ($r=.93$; $P<.01$) when using all seed sizes. Krieg (1975) summarized three years of date involving eight hybrid varieties of sorghum, 12 different levels of nitrogen fertilization at three or four locations (depending upon year), and found that the amount

of small seed left in the total quantity of sorghum harvested would be about 20-25% of the small seed or approximately 2-3% of the total sorghum being shipped to market. Therefore, less than 7% small size seed would be expected in any given quantity of sorghum.

TABLE 4. EFFECT OF SEED SIZE UPON VARIOUS NUTRITIONAL PARAMETERS OF SORGHUM[a]

Seed size	Bushel weight, lb.	Crude protein %	Gross energy (kcal/g)	Starch availability[b]	Gelatinization (mg maltose/g)
Small	52[c]	10.4[d]	4.35	20.7	460
Large	56	11.1	4.37	20.2	453
Mixture	54	10.9	4.39	20.3	459

[a]Six samples of sorghum separated into different sizes using a 2.8 mm and 3.36 mm sieve screen.

[b]Estimated as ml gas produced/hr/g of grain dry matter.

[c]Small seed lighter than large seed ($P<.10$).

[d]Small seed lower than large seed ($P<.01$).

Gas production per g of starch was compared with gas production per g of dry matter using 18 sorghum samples ranging in bushel weight from 40 lb/bu to 54 lb/bu. Gas production determined per g of starch was highly correlated with % cell wall constituents ($r= -.92$; $P<.01$), % cellulose ($r= -88$; $P<.05$), % hemicellulose ($r= -.88$; $P<.05$) and gas determined per g of dry matter ($r= 99.$; $P<.01$). Gas production per g of starch was not significantly correlated with bushel weight ($r= .08$). Similarly, gas production per g of dry matter was not significantly correlated with bushel weight ($r= .26$) when sorghum samples weighed above 40 lb/bu. Therefore, these data would indicate that gas production determined on a per g of starch basis and on a per g of dry matter basis are both reliable indicators of starch availability in sorghum grain for ruminants. Porter et al., (1973) also found that gas production was directly related to substrate DM loss, and that DM loss was approximately equal to starch loss.

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TECHNIQUES FOR EVALUATING GRAIN STARCH DAMAGE

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Summary

An in vitro yeast-amyloglucosidase manometric technique was compared with optical birefringence and maltose production by alpha (α), beta (β) and a mixture of α- and β- amylase for determining % starch damage (gelatinization) in corn and sorghum grains, steam flaked at various densities ranging from unprocessed (control) to 224.7 g/l. Starch damage determined with the gas production technique was significantly correlated ($P<.01$) with the results of all other procedures for both grains. These data indicate that all techniques may be used to estimate % starch damage of grains steam flaked at various densities. The yeast-amyloglucosidase manometric procedure is most easily conducted and therefore might be the preferred technique for routine analyses for grain starch availability and estimated % starch damage ($Y = 2.18X - .016$, where X = ml gas produced/hr/g of grain dry matter and Y = % starch damage).

Introduction

Various investigations have been reported which utilized in vitro techniques to estimate the availability of starch in various grains. A manometric technique utilizing yeast and amyloglucosidase for estimating starch availability was reported by Hinders and Freeman (1969). Hinders and Eng (1971) found a significant correlation (0.87) between starch availability as estimated by the gas production of various sorghum grains and the object of this study was to compare the in vitro yeast-amyloglucosidase manometric technique with optical birefringence and with maltose production by alpha (α), beta (β) and a mixture of α- and β-amylase for determining % starch damage (gelatinization) in corn and sorghum grains when steam flaked at various densities.

Experimental Procedure

Samples of corn and sorghum were flaked at various densities ranging from unprocessed (control) to 224.7 g/l. Starch availability (dry matter basis) was measured as gas production, displacement of 0.1N H_2SO_4 in 50-ml burets, from yeast utilization of sugars produced by amyloglucosidase digestion of starch (Hinders and Freeman, 1969; Porter et al., 1973). All gas production determinations were conducted in triplicate.

Percent starch damage (gelatinization) on a dry matter basis was determined by optical birefringence which was conducted commercially on each sample (Hi-Plains Laboratory, Hereford, Texas). Gelatinization was also estimated as mg maltose

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produced per g of sample by alpha (α)- amylase, beta (β)- amylase, and by a mixture of α- and β- amylase (Ralston-Purina Research 900 Technique, 1972). Because of the different levels of activity, 2 mg per sample of α-amylase, 2.8 mg per sample of β-amylase and .05 g per sample of α, β-amylase were used in the respective procedures. A maltose standard curve was established by using 10 to 100 mg maltose/ml, in 10 mg increments. The mg maltose produced by each sample before and after digestion was determined from the standard curve. Percent starch damage values from all procedures were expressed as a % of extruded standard grains with 100% starch damage. Linear correlation coefficients were determined according to Steel and Torrie (1960).

Results and Discussion

Table 1 shows values for the in vitro yeast-amyloglucosidase manometric technique, optical birefringence, and refractometer techniques for determining starch availability and percent starch damage. Table 2 shows the correlation coefficients for each procedure for determining starch availability. Starch availability as determined with the gas production technique was highly correlated with values for percent starch damage for both corn and sorghum. Gas production for corn (n=6) was found to be significantly correlated with optical birefringence (r=.97,P<.01), maltose production by α-amylase (r=.99, P<.01), maltose production by β-amylase (r=.91, P<.01) and maltose production by a mixture of α and β-amylase (r=.99, P<.01). Gas production for sorghum (n=20) was significantly correlated with optical birefringence (r=.92, P<.01), α-amylase maltose (r=.98, P<.01), β-amylase maltose (r=.90, P<.01) and α, β-amylase maltose (r=.99, P<.01). Correlations were slightly higher between in vitro yeast amyloglucosidase gas production and maltose production by amylase for corn (r=.97, P<.01) and sorghum (r=.96, P<.01) than between optical birefringence and amylase techniques (corn: r=.91, P<.01; sorghum: r=.92, P<.01).

Susceptibility of starch to enzymatic degradation was found to be increased as the density level at which the grains were flaked decreased from 465.6 g/l to 224.7 g/l. Similar results were reported by Osman et al., (1970).

Percent starch damage could be estimated by the manometric technique with sorghum grain using the equation $Y = 2.18X - .016$, where X = ml gas produced/hr/g of grain dry matter and Y = % starch damage.

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TABLE 1. PERCENT STARCH DAMAGE AS DETERMINED BY GAS PRODUCTION, OPTICAL BIREFRINGENCE AND REFRACTOMETER TECHNIQUES.

Sample	Techniques				
	Gas	Optical Birefringence	α, β-amylase	α-amylase	β-amylase
Corn					
Control	7.4	5	12.6	6.3	16.7
433.4 g/l	31.8	31	41.0	41.7	33.3
362.2 g/l	52.6	42	62.8	65.4	33.3
313.0 g/l	65.5	51	75.3	70.9	50.0
256.8 g/l	69.2	60	75.3	82.7	58.9
224.7 g/l	85.5	57	97.9	105.6	92.2
C42Y					
Control	8.6	15	16.0	11.8	14.3
449.4 g/l	53.6	31	53.4	52.7	35.2
362.2 g/l	72.6	31	72.7	70.9	42.9
337.2 g/l	71.8	38	75.2	70.9	50.5
256.8 g/l	95.3	45	84.9	82.7	63.8
G522					
Control	7.8	9	12.6	11.8	6.7
456.6 g/l	42.1	33	60.1	47.2	28.6
362.2 g/l	78.4	37	75.6	76.4	50.5
337.2 g/l	82.9	36	78.6	82.7	50.5
256.8 g/l	97.5	38	91.2	88.2	71.4
RS 671					
Control	7.0	12	12.6	5.5	6.7
465.6 g/l	55.6	33	60.0	65.4	42.9
401.4 g/l	74.2	41	72.7	76.4	57.1
321.1 g/l	79.4	37	78.6	82.7	85.7
256.8 g/l	95.0	44	94.1	93.7	85.7
Elevator Run Sorghum					
Control	7.7	12	12.6	5.5	14.3
465.6 g/l	55.3	40	56.3	59.1	42.9
393.3 g/l	68.1	40	69.7	65.4	57.1
337.2 g/l	70.0	42	75.6	82.7	79.0
240.8 g/l	89.8	42	88.2	88.2	63.8

TABLE 2. CORRELATION COEFFICIENTS FOR DETERMINING PERCENT STARCH DAMAGE

Item	Gas Production[a]		Optical Birefringence[a]	
Corn[b]				
Optical birefringence	.97		-	
∝, β - amylase	.99	avg.=.97	.95	avg.=.91
∝ - amylase	.99		.96	
β - amylase	.91		.81	
Sorghum[c]				
Optical birefringence	.92		-	
∝, β - amylase	.99	avg.=.96	.94	avg.=.92
∝ - amylase	.98		.94	
β - amylase	.90		.88	
Corn and Sorghum[d]				
Optical birefringence	.83		-	
∝, β - amylase	.98		.89	
∝ - amylase	.97		.90	
β - amylase	.89		.80	

[a] $P<.01$

[b] $N = 6$

[c] $N = 20$

[d] $N = 26$

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MONENSIN IN COMBINATION WITH VARIOUS IMPLANTS FOR FINISHING STEERS

L. B. Sherrod[1], W. C. Koers[2], J. C. Parrott[3] and C. B. Summers[1]

Summary

A 192-day finishing trial with steers was conducted to determine the effects on steer performance and carcass traits of using monensin with DES, Ralgro and Synovex-S implants. Daily gain improved with all three implants and increased slightly with monensin. Daily gain for monensin plus implants was the same as that for implants alone. Feed intake was depressed somewhat by monensin. Feed conversion was considerably more efficient with monensin. Further increases in efficiency occurred with combinations of monensin and implants with the greatest increase in efficiency resulting from the combination of monensin and Ralgro. Carcass traits were similar for all treatments.

Introduction

Research information concerning the use of monensin with implants is limited. An additive affect in improving performance, particularly efficiency of feed conversion, could provide an extremely important management system for reducing cost of gain in finishing cattle. Therefore, this study was conducted to evaluate the effects of combining monensin with DES, Ralgro and Synovex-S implants on steer performance as measured by daily gain, feed intake, feed conversion and standard carcass traits.

Procedure

Two hundred steers averaging 615 lb were randomly allotted in a 2 x 4 factorial arrangement of treatments involving 2 levels of monensin (control and 30 g/ton of ration) and 4 implant treatments (control, DES, Ralgro, Synovex-S) with five replications of 5 steers each per treatment for a 192-day feeding period. Steers were individually identified, weighed, and given routine vaccinations prior to allotment to treatments. Steers were implanted with the appropriate implant at the initiation of the trial. Rations contained 75 percent steam flaked sorghum grain, 15 percent cottonseed hulls, 4 percent cottonseed meal, and 6 percent alfalfa dehy supplement containing minerals, vitamins and urea. Monensin was incorporated into the appropriate rations using a cottonseed meal premix added to give the desired level. Rations were bunk-fed once daily at levels which allowed free-choice consumption between feedings. Steers were weighed at 28-day intervals with initial and final live weights determined from unshrunk weights using a 4% arithmetical shrink. Response criteria were 28-day weights, feed intake, efficiency of feed conversion (by pens), and standard carcass traits.

Results

Feedlot performance and carcass data are given in Table 1. Daily gain improved with all three implants. Monensin without implant resulted in a slight

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Table 1. Effect of Monensin and Various Implants Upon Feedlot Performance and Carcass Traits of Finishing Steers.

Monensin level, g/ton ration	0				30			
Implant	0	DES	Ral	Syn	0	DES	Ral	Syn
No. steers	25	25	24	25	22	24	21	25
Initial wt., lb.	614.0	616.5	615.6	615.7	613.7	618.8	606.9	616.4
Final wt., lb.	1031.4	1099.1	1092.1	1112.1	1064.1	1119.6	1084.2	1110.8
Daily gain, lb.	2.17	2.52	2.48	2.58	2.34	2.60	2.49	2.57
Daily feed, lb.	20.64	21.37	21.16	21.59	18.55	21.46	19.24	20.50
Feed/gain, lb.	9.49	8.51	8.54	8.37	7.96	8.25	7.74	7.99
Warm carcass wt., lb.	631.6	670.4	664.0	681.7	649.6	682.0	665.5	677.2
Dressing %	61.2	61.0	60.8	61.4	61.0	60.9	61.4	61.0
Carcass grade[a]	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Yield grade[b]	2.9	3.4	3.0	3.3	3.2	3.1	3.3	3.1
Abscessed livers, %	4.0	4.0	8.0	4.0	0.0	8.0	12.0	8.0

[a]Choice = 13

[b]Yield grade 2 = 52.3% of carcass weight in boneless, closely trimmed cuts from round, loin, rib and chuck; yield grade 3 = 50.0%; yield grade 4 = 47.7%.

increase in gain. Daily gain for monensin plus implants was the same as that for implants alone. Feed intake was depressed somewhat by monensin. Feed conversion was considerably more efficient with monensin. Further increases in efficiency occurred with combinations of monensin and implants with the greatest increase in efficiency resulting from the combination of monensin and Ralgro. The effects of the combination treatments were not additive to the extent of that potentially possible (Table 2). This may be partially explained by the larger than average improvement with monensin and individual implants when each was considered separately (Table 2). Carcass traits were similar for all treatments.

TABLE 2. PERCENT IMPROVEMENT OF FEED/GAIN WITH MONENSIN, IMPLANTS AND COMBINATIONS COMPARED TO CONTROL (0,0).

Item	Monensin alone	Implant alone	Potential cumulative effect	Actual cumulative effect
Implant,				
0	19.2	----	19.2	19.2
DES	19.2	11.5	30.7	15.0
Ral	19.2	11.1	30.3	22.6
Syn	19.2	13.4	32.6	18.9

Perry et al., (1975) and Burroughs et al., (1975) found that feed efficiency was improved over the control to a greater extent with monensin in combination with DES implant than with monensin or DES alone. The cumulative effects of the monensin - DES combination were additive and close to that potentially possible. However, the potential cumulative effect in their studies was lower than the potential effect in the present study. Similar improvements in efficiency were reported by Hale et al., (1975) when monensin was fed in combination with Synovex-S. Results from the current study indicate that DES, Ralgro and Synovex-S implants improved daily gain and feed efficiency and are consistent with those reported by Koers et al., (1974).

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MONENSIN AND TYLOSIN IN FINISHING STEER RATIONS

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Summary

Two finishing trials were conducted to evaluate monensin and tylosin in the ration upon steer performance and carcass traits. The first trial was a 2 x 4 experiment with monensin fed at levels of 0, 5, 20 and 30 g/ton and tylosin at 0 and 10 g/ton. Treatments in the second trial were control, 90 mg tylosin per head daily, 30 g monensin/ton of feed, and the combination of tylosin and monensin. In trial 1, daily gains were improved slightly by monensin and not affected by tylosin. Feed intake tended to decrease as monensin levels increased. Tylosin did not affect consumption. Efficiency of feed conversion was not affected by tylosin, but was improved by monensin with generally greater improvements as levels increased. Carcass traits were similar for all treatments. In trial 2, gains improved with the monensin and combination treatments. Feed intake was comparable for all treatments. Feed conversion was improved only by the 30 g/ton monensin level. Carcass traits were similar for all treatments, however incidence of abscessed livers was reduced by both tylosin and the tylosin monensin combination.

Introduction

Recent research indicates that monensin improves efficiency of feed conversion in finishing steers when fed at levels of 30 g/ton. Information is limited concerning the feeding of monensin in combination with other additives. The present studies were conducted to evaluate monensin and tylosin in various combinations upon feedlot performance and carcass traits of finishing steers.

Procedure

Trial 1. Two hundred crossbred (H x A) steers averaging 626 lb were allotted in a 2 x 4 experiment into 20 pens of 10 steers each for a 139-day feeding study involving monensin at 0, 5, 20 and 30 g/ton and tylosin at 0 and 10 g/ton. There were two replications (pens) on the 0 and 5 g/ton monensin treatments and 3 replications on the 20 and 30 g/ton levels. Composition of the control ration was (%): steam flaked milo, 80; cottonseed hulls, 10; cottonseed meal 4, and a mineral-vitamin-urea supplement in alfalfa dehy carrier, 6. Monensin and tylosin were incorporated into the rations by premixing with cottonseed meal and blending this mixture into the total ration to give the desired levels of monensin and tylosin per ton of final air-dry ration. All steers were individually identified, weighed and given routine feedlot vaccinations prior to allotment to treatment. Rations were bunk fed once daily at levels which allowed free choice consumption between feedings. Steers were weighed at 28-day intervals with recorded live weights determined from unshrunk weights using a 4% arithmetical shrink. Response criteria were average daily gain, feed intake, efficiency of feed conversion and standard carcass measurements.

Trial 2. Three hundred mixed steers averaging 730 lb were allotted into 30 pens of 10 steers each for a 112-day finishing trial. Main treatments were con-

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trol with 4 replications; 90 mg tylosin per head daily with 4 replications; 30 g monensin per ton of air-dry ration, 11 replications; and the combination of monensin and tylosin, 11 replications. Rations consisted of 85% steam flaked milo and 15% cottonseed hulls plus 1 lb supplement per head daily. The supplements contained the monensin and tylosin in the proper concentrations to provide the desired levels. Rations were fed twice daily at levels which allowed free choice consumption with the supplements topdressed on the morning feeding. Other procedures and response criteria were similar to those in Trial 1.

Results

Feedlot performance and carcass data for Trial 1 are given in Table 1. Average daily gains were improved by the 5 g/ton monensin level and decreased slightly with the two higher levels with gains for 30 g/ton level just slightly higher than the control (3.54, 3.48). Gains were similar (3.57 and 3.56) with the 0 and 10 g/ton tylosin levels. Feed intake tended to increase with the first monensin treatment then decrease somewhat as monensin increased. Consumption was generally not affected by tylosin. Efficiency of feed conversion was improved by both the 20 and 30 g monensin levels compared to the control, with the greatest improvement for 30 g/ton. Feed conversion was similar for the control and 10 g/ton tylosin treatments. Carcass traits were comparable for all treatments.

Performance data for Trial 2 are given in Table 2. Daily gains were improved by both the monensin and combination treatments. Feed intake was similar for all treatments with a slight tendency to increase with the monensin and combination treatments. Efficiency of feed conversion was increased with monensin and decreased somewhat by tylosin and the monensin plus tylosin treatments compared to the control. Carcass traits were comparable for all treatments. Incidence of abscessed livers was reduced by both treatments involving tylosin.

Treatments in Trial 1 similar to those in Trial 2 resulted in improved feed conversion compared to the control, whereas in Trial 2 the only improvement in efficiency was with monensin at 30 g/ton. Ali et al., (1975) reported that both gains and feed conversion were increased by tylosin and monensin fed alone, and further increased by the combination, indicating an additive effect of these two compounds.

Literature Cited

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Table 1. Feedlot Performance and Carcass Traits of Finishing Steers Fed Different Monensin and Tylosin Levels.

Tylosin, g/ton	0				10			
Monensin, g/ton	0	5	20	30	0	5	20	30
No. head	20	20	30	30	20	20	30	30
Initial wt., lb.	626.4	625.1	629.2	626.7	624.8	629.6	624.2	625.2
Final wt., lb.	1121.4	1124.8	1135.3	1110.0	1098.2	1147.2	1115.9	1125.6
Daily gain, lb.	3.56	3.60	3.64	3.48	3.40	3.72	3.53	3.60
Daily feed, lb.	25.8	27.7	24.8	21.9	23.9	28.0	24.4	23.5
Feed/gain, lb.	7.2	7.7	6.8	6.3	7.0	7.5	6.9	6.6
Warm carcass wt., lb.	656.5	657.5	668.0	648.3	644.5	675.0	653.6	660.0
Dressing percent	58.5	58.4	58.8	58.4	58.7	58.8	58.6	58.6
Carcass grade[a]	11.8	11.8	11.8	12.0	11.4	11.9	11.6	12.0
Marbling score[b]	5.4	5.1	5.1	5.4	5.2	5.5	5.1	5.6
Backfat, in.	.42	.48	.48	.47	.48	.48	.44	.48
Kidney fat, %	2.8	2.6	2.7	2.6	2.4	2.6	2.6	2.6
Ribeye area, sq. in.	11.4	12.0	11.7	11.4	11.0	11.8	11.8	11.7
Abscessed livers, %	0	0	0	0	0	0	0	0

[a]Good (thirds) = 9, 10, 11; Choice (thirds) = 12, 13, 14; etc.

[b]Small = 5; Modest = 6; etc.

Table 2. Effect of Monensin and Tylosin Upon Feedlot Performance and Carcass Traits of Finishing Steers.

Monensin, g/ton	--	--	30	30
Tylosin, mg daily	--	90	--	90
Initial wt., lb.	718.4	729.8	731.6	738.2
Final wt., lb.	1011.9	1012.4	1052.1	1052.4
Daily gain, lb.	2.61	2.51	2.85	2.79
Daily feed, lb.	20.87	21.45	22.16	22.66
Feed/gain, lb.	8.02	8.58	7.84	8.14
Warm carcass wt., lb.	573.4	578.2	604.2	606.3
Dressing percent	56.7	57.1	57.4	57.6
Carcass grade[a]	9.9	10.2	10.4	10.2
Marbling score[b]	4.0	3.9	4.2	4.1
Yield grade[c]	2.6	2.5	2.7	2.7
Backfat, in.	0.29	0.29	0.32	0.32
Kidney fat, %	2.7	2.5	2.6	2.8
Ribeye area, sq. in.	10.5	10.8	10.8	10.8
Abscessed livers, %	10.0	5.0	13.6	5.4

[a]Good (thirds) = 9, 10, 11.

[b]Traces = 3; slight = 4; small = 5.

[c]Yield grade 2 = 52.3% of carcass weight in boneless, closely trimmed cuts from round, loin, rib and chuck; yield grade 3 = 50.0%

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ACCEPTABILITY OF FEEDLOT RATIONS TOPDRESSED WITH DIFFERENT SUPPLEMENTS CONTAINING VARIOUS CONCENTRATIONS OF MONENSIN AND TYLOSIN

C. B. Summers and L. B. Sherrod*

Summary

Studies were conducted to determine the acceptability of top-dressed supplements containing various concentrations of monensin and tylosin. Ration consumption was not affected by supplement content, form, or level. Sorting score tended to increase with tylosin, monensin plus tylosin, level of monensin, and decreased with supplement level. Supplement type and monensin form did not affect extent of sorting.

Introduction

Previous research has shown that monensin slightly depresses feed consumption. The role of product acceptability in this depression has not been determined. Therefore, this study was conducted to evaluate the acceptability of top-dressed supplement with the following variables: level of monensin, level of tylosin, monensin plus tylosin, monensin form, supplement level, and supplement type.

Procedure

Three hundred steers averaging 664 lb. were allotted into thirty pens of ten steers each for a 28-day trial to study the acceptability of rations fed with different supplements containing various concentrations of monensin and tylosin (Table 1). Animals were fed free choice twice daily a ration containing 15 percent cottonseed hulls and 85 percent steamflaked sorghum grain. The supplements were top-dressed onto the rations as part of the morning feeding immediately after the ration was delivered to the bunk. Sorting score and feed weigh-back were taken before each morning feeding. The scoring system was 0 thru 3, with 0 indicating no sorting and 3 indicating obvious sorting. Level of supplement fed was taken into consideration when evaluating extent of sorting. Response criteria were daily feed intake and extent of sorting.

Results

Daily feed intake and sorting score are given in Table 1. Daily feed intake was similar for all treatments indicating that supplement content, form, and level did not affect ration consumption.

Sorting among main treatment groups was highest for those pens receiving monensin and monensin plus tylosin, somewhat less for those receiving tylosin alone, and lowest for the control containing neither additive. Sorting was the same for monensin plus tylosin and monensin alone indicating that sorting of monensin and tylosin was not additive. Sorting was considerably greater for

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TABLE 1. FEED CONSUMPTION AND SORTING SCORE OF FEEDLOT RATIONS TOPDRESSED WITH SUPPLEMENTS CONTAINING DIFFERENT CONCENTRATIONS OF MONENSIN AND TYLOSIN.

Item	Ration Consumption[a]	Sorting Score
MAIN TREATMENTS		
Control	22.18	0.2
Monensin	21.83	1.9
Tylosin	22.78	1.0
Monensin + Tylosin	21.70	1.9
MONENSIN LEVELS		
0	22.48	0.6
10g/ton ration	21.17	1.8
20g/ton ration	23.08	1.5
30g/ton ration[b]	21.56	2.1
TYLOSIN LEVELS		
0	21.92	1.5
90 mg/hd/day[b]	21.99	1.7
MONENSIN FORMS		
Mycelial	22.04	1.9
Crystalline	21.04	2.0
SUPPLEMENT LEVELS		
0.5 lb/hd/day	22.36	2.0
1.0 lb/hd/day	21.66	1.5
2.0 lb/hd/day	22.42	1.3
SUPPLEMENT TYPE		
Meal	21.52	1.6
Pellets	22.08	1.6

[a] lb/hd/day.

[b] Additive concentration per ton of supplement varied with supplement feeding rate in order to maintain a constant additive concentration per ton of ration.

those pens receiving all levels of monensin than for those receiving no monensin, with the pens receiving 30 g. monensin/ton of ration having the highest sorting score. Sorting score was the same for 0 and 90 mg levels of tylosin which could be due to the fact that some pens assigned to each tylosin level also received monensin. Monensin form and supplement type did not affect sorting score. Sorting tended to decrease as supplement level increased which may have been related to concentration of the additive in the supplement. Sorting scores for pens receiving the 0 level of monensin, 0 level of tylosin, and the control for the main treatments were different. This might be explained on the basis that the control for the main treatment received neither additive, whereas some pens receiving no monensin did receive tylosin and some receiving no tylosin did receive monensin.

Results from this study indicate that supplement content, form, and level did not affect ration consumption. Sorting score tended to increase with tylosin,

monensin plus tylosin, level of monensin, and decreased with supplement level. Monensin form and supplement type did not affect extent of sorting.

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This study was partially supported by Eli Lilly and Co., Greenfield, Indiana. Appreciation is extended to Dr. Nolie G. Elliston for his cooperation and assistance in conducting this trial.

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METHODS FOR INTRODUCTION OF MONENSIN IN FINISHING STEER RATIONS

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Summary

A finishing trial was conducted to evaluate methods for gradual introduction of monensin up to the recommended level in steer finishing rations. Treatments were: control; 30 g monensin/ton air-dry ration; 10 g monensin/ton for 7 days with 30 g/ton thereafter; and 10 g/ton for 21 days with 30 g/ton thereafter. Daily gains were similar for all treatments. Feed intake was somewhat lower for all monensin treatments with little difference among the different methods of introducing monensin. Efficiency of feed conversion was improved by all monensin treatments compared to the control with no appreciable difference among monensin treatments. Carcass traits were comparable for all treatments. These results indicate that intake reductions and increased efficiency of feed conversion were essentially not influenced by method of introduction of monensin into the ration.

Introduction

Several recent trials have shown that monensin improves efficiency of feed conversion in finishing steers, however feed intake has also tended to be reduced with recommended levels of monensin (30 g/ton). This decrease in intake could possibly be reduced by a feeding program based upon gradual build-up of monensin to desired levels. The trial reported herein was conducted to evaluate methods for gradual introduction of monensin to the recommended level in steer finishing rations.

Procedure

Two hundred crossbred (H X A) steers averaging 549 lb were allotted into 4 main treatment groups with 5 replications of 10 steers per treatment for a 208-day finishing trial. The main treatments were: control; 30 g monensin per ton of air-dry ration; 10 g monensin per ton for 7 days with 30 g per ton thereafter; and 10 g monensin per ton for 21 days with 30 g monensin per ton air-dry ration thereafter. Composition of the control ration was (%): steam flaked milo, 80; cottonseed hulls, 10; cottonseed meal, 4; and a mineral-vitamin-urea supplement in alfalfa dehy carrier, 6. Monensin was incorporated into the ration by premixing with cottonseed meal and blending this mixture into the total rations to give the desired levels of monensin per ton of final air-dry ration. All steers were individually identified, weighed, given routine feedlot vaccinations and allotted into treatment groups. Rations were bunk-fed once daily at levels which allowed free choice consumption between feedings. Steers were weighed at 28-day intervals with recorded live weights determined from unshrunk weights using a 4% arithmetical shrink. Performance criteria were average daily gain, feed consumption, efficiency of feed conversion, and standard carcass traits.

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Results

Feedlot performance and carcass data are given in Table 1. Average daily gain was similar for all treatments. Daily feed intake was slightly lower for the monensin treatments with little difference in intake among the different monensin introductory methods. Efficiency of feed conversion was improved by all monensin treatments compared to the control, with similar improvement for all monensin treatments. Average reduction in feed/gain for the three monensin treatments was 0.59 lb. which represented a 7.4% improvement compared to the control. Carcass traits were comparable for all treatments.

Results from this trial suggest that the two methods used for gradually introducing monensin to the recommended 30g/ton of ration were not superior in preventing reduced feed consumption to adding 30 g/ton initially. Feed intake was also similar for the three methods during the early phase of the trial. These data indicate that reductions and improvement in feed conversion were essentially not influenced by method of introduction of monensin into the ration.

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This study was partially supported by Eli Lilly Co., Greenfield, Indiana. Appreciation is extended to Dr. Nolie G. Elliston for his cooperation and assistance in conducting this trial.

Table 1. EFFECT OF GRADUAL INTRODUCTION OF MONENSIN INTO RATIONS UPON FEEDLOT PERFORMANCE AND CARCASS TRAITS OF FINISHING STEERS.

Initial monensin level, g/ton	0	30	10-7 days	10-21 days
Final monensin level, g/ton	0	30	30	30
Initial wt., lb.	548.8	545.9	551.5	549.1
Final wt., lb.	1096.6	1082.6	1097.5	1075.4
Daily gain, lb.	2.64	2.57	2.61	2.61
Daily feed, lb.	22.54	20.41	20.82	20.80
Feed/gain, lb.	8.55	7.93	7.97	7.99
Warm carcass wt., lb.	651.7	643.3	654.2	658.0
Dressing percent	59.4	59.4	59.6	61.2
Carcass grade[a]	6.6	7.1	7.1	6.7
Marbling score[b]	4.8	5.4	5.2	5.2
Backfat, in.	0.51	0.50	0.50	0.51
Kidney fat, %	2.6	2.6	2.6	2.6
Ribeye area, sq. in.	10.9	10.9	11.1	11.2
Abscessed livers, %	12.0	12.0	12.0	18.0

[a]Good plus = 6; Choice minus = 7; Choice = 8.

[b]Slight = 4; Small = 5; Modest = 6.

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BLUEWEED CONTROL WITH FOLIAGE TREATMENTS

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Summary

Herbicide treatments resulting in the most effective blueweed control one and three months following application were Esteron 99 concentrate, Lithate, Formula 40, Banvel with surfactant, Banvel K and Velpar with surfactant.

Introduction

Blueweed is a deep rooted perennial sunflower that is native to the Texas Panhandle. It is most competitive with summer grown crops. Trials were applied in the summer of 1975 to determine if several new herbicides were better suited for the control of blueweed than presently used hormone type herbicides.

Procedure

Plot size was 10 ft. by 25 ft. replicated three times in a randomized block. Herbicides were applied with a cub tractor mounted sprayer operated at 3 mph and 30 psi to apply 26 gallon per acre. At time of herbicide application on 6-12-75, soil moisture was excellent and blueweed were 20 inches tall and in the bud stage.

Results

Blueweed control data obtained one and three months following application are found in Tables 1 and 2. One month after application, most herbicides were giving good topkill with complete control resulting from treatments employing 2, 4-D and Vanvel. At three months, complete control was not as evident but most treatments were giving better than 80 percent blueweed control. Best blueweed control was evident on areas treated with Banvel K, Banvel with surfactant and Velpar with surfactant.

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Table 1. Percent blueweed control one and three months following herbicide treatment on 6-12-75.

Herbicide	Lb/A (ai)	% Blueweed control 7-14-75	% Blueweed control 9-9-75
Krenite + S[a/]	2	25 d	27 d-f
	4	37 d	28 d-f
Krenite + Formula 40	2 + 1	73 bc	40 c-f
	4 + 2	96 a	65 a-d
Velpar + S	3	96 a	92 a
AAtrex + Esteron 99 concentration + Oil[b/]	1 + 1	90 ab	47 b-e
Vel 5026 + S	2	98 a	90 ab
Banvel + Activate 101	1 + 0.32	100 a	78 a-c
Lexone + S	2	87 ab	3 ef
Ansar 529 HC	3	65 c	30 d-f
Check		0 e	0 f

a/ DuPont WK surfactant at 0.5% of carrier (1 pint in 25 gallons).

b/ 1 gallon per acre of Sun Oil Corporation non-phytotoxic emulsifiable oil.

Table 2. Percent blueweed control one and three months after application of chemicals on 6-12-75.

Herbicide	Lb/A (ai)	% Blueweed control 7-14-75	9-9-75
Roundup	1	25 c	32 d
	1.5	55 b	52 d
	2	59 b	73 a-c
	3	96 a	88 a
Esteron 99 Conc. + oil[a/]	2	100 a	80 a
Lithate 2,4-D + S[b/]	2	96 a	88 a
Formula 40 + S	2	99 a	89 a
Banvel + S	2	100 a	97 a
Banvel K	0.32 + 0.64	93 a	75 ab
	0.64 + 1.28	100 a	94 a
Check		0 d	0 e

a/ Orchex 795 at 1 gallon per acre

b/ Dupont Surfactant WK at 0.5% of carrier (1 pint in 25 gallons)

Table 3. Herbicides used in order of appearance in tables.

Designation or trade name	Chemicals or WSSA name	Formulation	Manufacturer
Roundup	Glysophate	3 lb/gal	Monsanto
Esteron 99 Conc.	Propylene glycol butyl ether ester of 2,4-D	4 lb/gal	Dow
Oil	Non-phytotoxic oil with 2% emulsifier	100 % liquid	Sun Oil Corp.
Lithate	Lithium salt of 2,4-D	95%	Guth Corp.
S(WK Surfactant)	Dodecyl ether of poly-ethylene glycol	100 % liquid	Dupont de Nemours & Co., Inc.
Formula 40	Alkanolamine salts of 2,4-D	4 lb/gal	Dow
Banvel	Dicamba	4 lb/gal	Velsicol
Banvel K	Dicamba + 2,4-D	4 lb/gal	Velsicol
Krenite	Ammonium ethyl carbamoylphosphonate	4 lb/gal	Dupont de Nemours & Co., Inc.
Velpar	3-cyclohexyl-6-(dimethylamino)-1-methyl-s triazine-2,4-(1H,3H)-dione	90% WP	Dupont de Nemours & Co., Inc.
AAtrex	Atrazine	80% WP	CIBA-Geigy
Vel 5026	Unavailable	75% WP	Velsicol
Lexone	Metribuzin	50% WP	Dupont de Nemours & Co., Inc.
Ansar 529 HC	MSMA	6 lb/gal	Ansul

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EFFECT OF METHOD OF INCORPORATION AND TIME OF FURROW IRRIGATION ON JOHNSONGRASS CONTROL WITH PREPLANT HERBICIDE

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Summary

Following preplant treatment and incorporation on furrow irrigated land, Johnsongrass control was best when spring irrigation was delayed until after corn planting. An average of 11.2 tons of dry matter per acre of corn silage was harvested when this method of watering was employed. In contrast when furrow irrigation was applied prior to corn planting average corn silage dry matter yield was only 7.6 tons per acre.

Applying herbicides to flat ground and incorporating with a disk or spraying bed and incorporating with a rolling cultivator had little or no effect on Johnsongrass control resulting from preplant treatments.

Effective Johnsongrass control resulted in corn silage yields that were 30-75% better than those harvested from untreated checks. Best Johnsongrass control was accomplished with 8 pounds per acre of either Eradicane and Sutan +.

Note! This is twice the labeled rate of these herbicides. Because of potential crop injury this high rate of application should not be used until additional tests are conducted.

Introduction

Because of early seasonal planting, corn stand is usually well established prior to the emergence of most weed species. Thus, corn has the competitive edge. However, Johnsongrass emerges early season and poses an immediate threat to corn. Therefore, all factors that affect effectiveness of preplant herbicide treatments for controlling Johnsongrass are of the upmost importance in obtaining maximum corn yields in Johnsongrass infested fields.

Procedure

In the spring of 1975, ten preplant treatments were applied using two methods of incorporation and two times of irrigation to determine which procedure gave best Johnsongrass control in furrow irrigated corn.

Preplant treatments were either incorporated on flat land with two passes of a tandem disk or with two passes of a rolling cultivator on previously bedded land. Following preplant treatment and bedding of land on 3-22-75, part of the study was pre-watered on 4-15-75 prior to corn planting. The pre-watered area was irrigated again after planting. The other portion of study was planted and then furrow irrigated.

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KT680 corn was planted on 4-25-75. Rates of herbicide (active ingredient) used are shown in Tables 1 to 4. Herbicides used are described in Table 5. Preplant treatments were applied broadcast with 14 gpa water. Plot size was 12 forty-inch rows 50 feet long. Treatments were replicated two times. Soil type was Pullman clay loam which contains one third each of sand, silt, and clay and about 1.5% organic matter. Johnsongrass and annual weed control, as well as corn injury, was estimated on 6-12-75 and corn and Johnsongrass yields were obtained by hand harvesting.

Results

Visual estimates of Johnsongrass control obtained on 6-12-75 revealed that time of furrow irrigation affected herbicide effectiveness, Table 1. Significantly better Johnsongrass control was obtained when corn was planted and watered up with furrow irrigation. Method of incorporation had no significant effect on Johnsongrass control obtained with preplant treatments.

Overall best Johnsongrass control was obtained with eight lb/A of Eradicane or Sutan +. Some early corn injury was observed from preplant treatments that were disk incorporated and corn was watered up after planting, Table 2. At harvest an average of 5.2 tons per acre of dry Johnsongrass was harvested from untreated check plots, Table 3. Corn silage yields obtained from check areas averaged only 6 tons per acre. In contrast, preplant treatments that gave good Johnsongrass control yielded 10 to 14 tons per acre of corn silage, Table 4.

Note! 8 lb is twice the labeled rate of these herbicides. Because of potential crop injury this high rate of application should not be used until additional tests are conducted.

Table 1. Johnsongrass control on 6-12-75 resulting from application of preplant herbicides.

Herbicide	Lb/A (ai)	Method of incorporation and watering: Disk inc. water upa/	Disk inc. pre-waterb/	Rolling cultivator water up	Rolling cultivator pre-water	Average
		% Johnsongrass control				
Eradicane	4	70	65	65	65	66 a-c
	6	70	35	90	80	69 a-c
	8	83	68	88	90	82 a
Sutan+	4	58	40	63	60	55 bc
	6	60	70	89	70	72 ab
	8	70	92	88	75	81 a
Lasso	4	53	65	60	30	52 bc
AAtrex 80W	4	60	48	50	30	47 c
Sutan + AAtrex	4 + 2	68	68	75	35	61 a-c
	8 + 2	88	23	83	85	69 a-c
Check		0	0	0	0	0 d
Average method		62 ab	52 b	68 a	56 ab	

a/ Furrow irrigation applied after herbicide treatment and after corn palnting.

b/ Furrow irrigation applied after herbicide treatment and prior to corn planting and again after corn planting.

Table 2. Corn injury on 6-12-75 resulting from the application of preplant herbicides.

Herbicide	Lb/A (ai)	Method of incorporation and watering: Disk inc. water up	Disk inc. pre-water	Rolling cultivator water up	Rolling cultivator pre-water	Average
				% Corn injury		
Eradicane	4	10	5	8	3	6 b-d
	6	15	0	3	0	4 cd
	8	18	5	5	3	8 bc
Sutan+	4	13	0	0	5	4 cd
	6	18	0	8	3	7 b-d
	8	20	3	3	13	9 bc
Lasso	4	15	0	5	0	5 cd
AAtrex 80W	4	35	18	18	8	19 a
Sutan + AAtrex	4 + 2	13	5	8	0	6 b-d
	8 + 2	40	8	5	0	13 ab
Check		0	0	0	0	0 d
Average method		18 a	4 b	6 b	3 b	

Table 3. Corn yields resulting from the application of preplant herbicides, 1975.

Herbicides	Lb/A (ai)	Method of incorporation and watering: Disk inc. water up	Disk inc. pre-water	Rolling cultivator water up	Rolling cultivator pre-water	Average
		Corn silage - Tons per acre				
Eradicane	4	11.6	6.0	9.8	8.9	9.1 a-c
	6	14.0	10.5	13.8	9.9	12.0 a
	8	14.5	9.6	13.6	9.6	11.8 a
Sutan+	4	13.5	8.2	10.3	7.0	9.8 ab
	6	11.9	8.2	11.7	6.6	9.6 ab
	8	12.3	9.6	11.2	9.1	10.6 ab
Lasso	4	7.9	5.6	8.1	7.7	7.3 bc
AAtrex 80W	4	8.5	5.0	9.6	6.0	7.3 bc
Sutan + AAtrex	4 + 2	10.4	8.6	13.4	7.3	9.9 ab
	8 + 2	12.8	7.5	12.2	8.2	10.2 ab
Check		7.2	4.3	8.2	4.4	6.0 c
Average method		11.3 a	7.6 b	11.1 a	7.7 b	

Table 4. Johnsongrass yields obtained following the application of preplant herbicides, 1975.

Herbicides	Lb/A (ai)	Method of incorporation and watering: Disk inc. water up	Disk inc. pre-water	Rolling cultivator water up	Rolling cultivator pre-water	Average
		Johnsongrass - Tons per acre				
Eradicane	4	2.9	4.1	4.0	2.7	3.4 a-c
	6	3.4	2.5	4.5	3.5	3.5 a-c
	8	3.3	2.5	2.5	2.6	2.7 b c
Sutan[+]	4	1.3	3.5	2.9	6.3	3.5 a-c
	6	2.9	1.5	2.0	3.4	2.4 bc
	8	2.2	0.7	2.0	3.1	2.0 c
Lasso	4	2.6	5.5	4.4	3.6	4.0 ab
AAtrex 80W	4	4.6	5.1	2.2	4.4	4.1 ab
Sutan + AAtrex	4 + 2	1.5	4.6	2.0	3.9	3.0 bc
	8 + 2	2.9	3.5	5.0	3.6	3.8 a-c
Check		4.6	5.7	4.8	5.5	5.2 a
Average method		2.9 a	3.6 a	3.3 a	3.9 a	

Table 5. Herbicides used in order of appearance in tables.

Designation to trade name	Chemicals or WSSA common name	Formulation	Manufacturer
Eradicane	EPTC + antidote	6.7 lb/gal[a/]	Stauffer
Sutan+	Butylate + antidote	6.7 lb/gal	Stauffer
Lasso	Alachlor	4 lb/gal	Monsanto
AAtrex	Atrazine	80% WP[b/]	Ciba-Geigy
Sutan	Butylate	6 lb/gal	Stauffer

a/ Signifies active ingredient per gallon of liquid.

b/ Signifies a wettable powder formulation.