1968

Controlling bloat in cattle grazing clover

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Controlling Bloat
In Cattle Grazing Clover

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DOYLE CHAMBERS, DIRECTOR

August 1968
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## Acknowledgments

The authors express appreciation to Dr. George Hindry, Mr. A. J. Guidry, Mr. E. J. Stone, and Mr. C. P. Breidenstein for assisting in the collection of data and to Dr. P. B. Brown for assisting in animal procurement.
Controlling Bloat in Cattle Grazing Clover


Summary

Research was conducted on prevention of clover bloat in cattle during the years 1958 through 1962, and 1964 through 1967. It was found that properly managed, young, fast growing Ladino clover plants were of high bloat induction potential and provided a reliable means of evaluating the effectiveness of bloat preventives in cattle.

It was demonstrated that death of cattle due to clover bloat is not caused by a chemical phenomenon but rather by excessive intraruminal pressure (physical) which prevents diaphragmatic contractions, and therefore respiration, followed by heart failure.

Penicillin administered to individual cattle daily by mouth in a gelatin capsule with a balling gun, and penicillin provided free choice in salt, prevented severe and lethal clover bloat in cattle for one to two weeks.

“Pets,” a combination of penicillin, erythromycin, tylosin, and streptomycin, provided free choice to cattle in a pelleted feed, prevented severe and lethal clover bloat in cattle for 46 days.

“Step” boluses, also a combination of the antibiotics referred to above, prevented severe and lethal bloat in steers for one month. Each steer was administered two boluses by mouth at the beginning of the treatment period.

Resistopen, a semisynthetic penicillin, administered every other day by mouth in a gelatin capsule with a balling gun, also prevented severe and lethal bloat in treated cattle for four weeks.

The use of antibiotics and poloxalene showed promise in preventing clover bloat in cattle; however, the use of antibiotics did not prove practical.

Poloxalene, a nonionic surfactant, in salt-molasses blocks (30 grams per pound of block) when used judiciously is an effective, practical, and economical means of preventing severe and lethal bloat in cattle grazed on clover with high bloat induction potential.
Introduction and Review of Literature

According to Tribe (45)\(^5\), bloat was recorded in literature by an ancient Roman author as early as A.D. 60. Recently it has been defined as a noninfectious disease (28) which is common in ruminants in many parts of the world. Legume (clover and alfalfa) bloat in ruminants results from the accumulation of stable foam (froth) in the rumen (paunch) which prevents eructation or belching (11, 29). Stable froth accumulates in rumens of cattle which bloat on feedlot rations, but the mechanism of pasture (legume) bloat and that of feedlot bloat are not the same (47). It is estimated that the morbidity and mortality due to bloat costs livestockmen 100 million dollars annually (46). The great loss in Louisiana, however, is due to the fact that clover, a high-quality forage, in recent years has not been generally used in pasture improvement practices. Cattle will gain up to 2.5 pounds per head per day when grazed on good clover. In addition, clover will fix from 50 to 250 pounds of atmospheric nitrogen per acre each season depending on density of stand, growth produced, length and nature of growing season, soil fertility, and degree of effective inoculation of clover seed with symbiotic bacteria (47). High-quality grasses may accompany and/or follow the growth of good stands of clover.

The mechanism of clover bloat is complex and logically results from the proper interaction of bloat inducing plants that are consumed in sufficient amounts by bloat susceptible cattle or sheep, and the ruminal microbial population.

Plant Factors

Young, fast growing, succulent plants are essential for the production of clover bloat in Louisiana. It was reported that lush Ladino clover had a greater bloat induction potential than did common white or Louisiana S-1 clover (32). It is probable that more than one substance in clover is present in sufficient quantities to induce bloat in ruminants.

It was reported that alfalfa saponins (35) may be important in the production of stable foam. However, another report (4) indicated there was little correlation between saponin content and bloating potential of clover and other legumes.

Several reports (13, 14, 23, 24, 25, 40, 41) indicate that pectin and/or pectic substances play an important role in the production of stable foam in legume bloat. Girouard (23) reported that the total pectic substances in well-managed, rapidly-growing Ladino clover varied from 9.41 to 10.98 per cent as compared with 4 per cent of the same substances in alfalfa hay.

The crude protein content of Ladino clover was reported to vary from 23.2 to 27.5 per cent, as compared with 16.1 per cent for crude protein in alfalfa hay (23). It has been suggested that the foaming

\(^5\)Italic numbers in parentheses refer to Literature Cited, page 26.
agent in legumes which causes bloat is probably a cytoplasmic protein (37). Recently it has been identified as the 18-S protein, which is a chloroplastic protein (38).

Animal Factors

It has been reported that nonbloating cattle have higher levels of sera epinephrine than do cattle that bloat (16). The importance of saliva in preventing bloat has been reported (9, 11, 39, 49). Some researchers indicate the important animal factor that prevents bloat is the mucin in saliva (6, 18, 36). They suggest that if the ruminal flora of a ruminant grazing legume pasture is composed of mucinolytic bacteria, which destroy the mucin, bloat will result. It is also suggested the disease will result if inadequate amounts of saliva are secreted (6). Studies at this station, using Ladino clover pastures with high bloat induction potential, showed some wide variations in bloat severity of the same animals from the morning to afternoon grazing periods of the same day, as well as variations in bloat severity of the same animals after corresponding grazing periods from day to day. This suggests that the cause of clover bloat is quite complex and possibly results from several interacting plant, animal, and microbial factors.

Microbial Factors

Certain types of ruminal bacteria (6, 8, 18, 26, 36) and ruminal protozoa (10, 34) have been reported to be associated with bloat production. It appears that the bacteria and/or protozoa are very important factors in clover bloat, because bloat-susceptible cattle must graze clover pastures with excellent bloat induction potential for two to three days and some animals must graze clover for two weeks or more before they bloat. This suggests the ruminal microbial population probably must undergo definite changes before stable foam is produced and bloat results.

It appears that legume bloat in ruminants results from the interaction of more than one plant, animal, and microbial factor discussed above. Future research may reveal additional plant, animal, or microbial factors which are very important in bloat production.

Bloat Prevention

Various methods and materials have been used to prevent clover bloat in cattle. Hay has been fed cattle before turning them to clover pasture, and this has apparently given good results in preventing bloat in some instances. Some stockmen have pastured grass and clover alternately to prevent cattle from bloating, with apparent good results. However, such a practice demands constant attention, and this increases costs.

Antibiotics (2, 3, 19, 20, 33) have been used to prevent legume bloat in cattle with good results, the effect varying from seven days to four weeks or longer. Combinations of antibiotics were generally effective for longer periods of time than were antibiotics used singly. One
investigator (17) reported that antibiotics (penicillin, erythromycin, tylosin, and streptomycin) caused undesirable digestive effects in experimental cattle. The same antibiotics used in slow-release boluses gave good results when the boluses were not regurgitated by the cattle (19). The use of antibiotics in bloat prevention lost favor because of the uncertainty of getting all animals to consume the required daily amounts when offered in grain or salt-antibiotic mixtures, and also because some of the antibiotics were not approved by the Food and Drug Administration for use in bloat prevention.

Alkyl aryl sulfonate sodium has been reported to be effective in preventing bloat in cattle grazed on alfalfa (77). Reportedly this substance is a plant enzyme inhibitor (pectin methyl esterase), and can be fed daily to cattle in a grain mix to prevent bloat. Getting cattle that are grazing on lush clover pastures under range conditions to consume adequate quantities of this material in a grain mix probably would be difficult.

Various other materials such as animal, vegetable, and mineral oils, detergents, and surfactants have been used as bloat preventives (7, 12, 15, 29, 30, 31, 42, 43, 44, 48). None of these have proved practical.

Poloxalene, a nonionic surfactant, has been used as a legume bloat preventive (5, 21, 22, 27). Recent research (1) indicated that poloxalene had no effect as a treatment on rumen pH of cows grazing Ladino clover, nor did it cause the pH to vary with the rumen strata. Although it is not ideal, it has practical application in the management of beef and dairy cattle grazed on good clover pastures.

**Experiments by the Louisiana Station, 1958-67**

**Pastures and General Management**

During the spring of 1958 clover bloat studies were conducted on approximately eight acres of Louisiana S-1 white clover. After the 1958 study, 22 acres of land close to an irrigation well were assigned to the bloat project. Equal portions of this land were planted in Ladino, Louisiana S-1, and common white clover in the Octobers of 1958, 1959, and 1960. Beginning in the fall of 1961, only Ladino clover seed was planted. Good stands of clover were obtained each year with the exception of the fall of 1962, when climatic conditions prevented growth of the newly seeded clover. Therefore, bloat research was not conducted in the spring of 1963.

Each spring the clover was clipped and irrigated periodically to ensure rapidly growing clover plants with high bloat induction potential, and the 22-acre field was divided into three or six pastures of approximately equal size to facilitate proper management of the cattle on the clover. Experimental cattle were grazed twice daily, with the morning grazing periods of two hours starting at 6:00 A.M. and the afternoon grazing periods of two hours at 3:00 P.M. This routine was followed except during spring and summer months of 1964, 1965, and 1967, when
the bloat induction potential of the clover was so high that each grazing period (morning and afternoon) had to be periodically reduced by increments of 15 minutes to prevent the development of lethal bloat in the control animals. Grazing periods as short as 30 to 50 minutes were used in 1964, 1965, and 1967.

All cattle used in the experiments had been maintained on hay, grass pasture, or both before they were placed on clover. Therefore, it was necessary each year to condition the cattle to bloat, i.e., graze them on clover for a number of days before a representative percentage of the cattle bloated. This part of each experiment is referred to as the conditioning phase and preceded the treatment phase. The cattle were individually identified with neck numbers or hip and neck numbers.

Between grazing periods the experimental cattle were placed in holding lots adjacent to the clover pastures. Water, salt, and shade were available.

The experimental cattle were observed for at least one hour after each grazing period, and incidence and severity of bloat of each animal were graded and recorded according to the following scale:

0 – No bloat. No distension.
1 – Mild bloat. Obvious distension of left paralumbar fossa.
2 – Moderate bloat. Pronounced abdominal distension of both left and right sides with frequent defecation or urination, or both.
3 – Severe bloat. Animal very uncomfortable with rapid respiration, frequent lying down and arising, walking backwards, open mouth breathing, kneeling, etc.
4 – Lethal bloat. Animal down and unable to rise, with cessation of breathing. Death is certain unless rumenotomy is performed and/or artificial respiration is applied.

1958 Procedure I

A. A new stand of Louisiana S-1 white clover was grazed, starting in mid-March, with a mixed herd of yearling steers and dry dairy cattle for two 2-hour grazing periods daily. This study was conducted to determine conditions necessary for production of experimental bloat. The cattle were grazed on clover 12 inches high. In early May the dairy cattle were replaced with additional yearling steers. The clover grazed by these cattle was six to eight inches high.

B. Samples of clover grazed by experimental cattle were taken periodically to determine the nitrate-nitrogen content of the forage.

1958 Results and Discussion I

A. Dairy cattle, with one or two exceptions, did not show as much bloat as yearling steers. Bloat incidence was highest when the cattle grazed rapidly-growing immature clover which had received rain within the previous two days. Little bloat was observed when the cattle grazed clover 12 inches or more in height. The onset of maximum temperatures exceeding 90° F slowed clover growth and eliminated bloat incidence.
B. Nitrate-nitrogen content of clover grazed by experimental cattle showed a wide fluctuation which coincided with incidence of rainfall. There was a tendency for high levels of nitrate-nitrogen to be associated with bloat incidence.

1958 Procedure II

During the period of March 31-May 3, 1958, a controlled field experiment under range conditions and using a salt-penicillin mixture to prevent bloat was arranged with a local cattleman. The cattle consisted of 134 grade Brahman-Hereford cows, most of which had calves, and five Hereford bulls. These 139 animals were divided into control and experimental groups. The control cattle, Group 1, consisted of 35 cows and one bull; the treated cattle, Group 2, consisted of 99 cows and four bulls. The two groups were placed in separate but adjacent pastures of nearly pure stands of Louisiana S-1 white clover. During the two-week period previous to the initiation of the experiment several cows had died of bloat while grazing these pastures.

Group 2 was provided "Mortons" salt-penicillin mixture, free choice, in a covered mineral box, with the supply being replenished as needed during the experimental period. Group 1, the controls, received no mineral supplement. Both groups were checked for bloat daily between 2:00 P.M. and 4:00 P.M. During periods of high incidence of bloat the cattle were also observed during the mornings.

![Diagram](image)

FIGURE 1.—Effects of the use of penicillin in salt on the incidence of bloat in cattle grazing clover pasture under range conditions.
1958 Results and Discussion II

As shown in Figure 1, the salt-penicillin mixture apparently reduced bloat incidence in Group 2 during the first two weeks of the study. Beginning on April 19 through April 24 it appeared that the clover did not induce bloat in the control or treated cattle. However, from April 24 through April 29 the clover induced bloat in both the control and treated cattle. During this time it was apparent that penicillin lost its effectiveness. After April 30 the clover stopped growing. One animal in Group 1 died during the third week of the study. No animals in Group 2 died; however, several were treated by trocarization or with "Turcapsol," a commercial remedy. The experienced herdsmen believed that the animals would have developed lethal bloat if they had not been treated.

There was no way to determine whether all the cattle provided the salt-penicillin mixture consumed the material daily. Therefore, it was difficult to evaluate the study.

1959 Procedure

Studies were conducted to determine differences in bloat incidence among breeds of cattle and differences in the tendency of animals to bloat on three varieties of white clover. Studies of climatic factors and possible influence in day-to-day variations in bloat incidence were conducted concurrently. Twenty-two acres of Mississippi River bottomland were divided into three plots of approximately equal size. One was seeded to common white clover, one to Louisiana S-1 white clover, and one to Ladino clover during the fall of 1958.

On April 1, 1959, the herd of cattle was placed on the clover. The herd consisted of 15 aged Brahman cows, 10 aged Angus cows, four aged Hereford cows, nine yearling Hereford steers, seven 2-year-old heifers (five Holsteins, two Jerseys), and one fistulated Holstein cow. Aged cows were eight to nine years old. On April 24 the cattle were divided into three groups so that breed and age groups were represented nearly equally in each group. From April 24 to May 20 each group was grazed on each of the varieties of clover. Animals were rotated among groups during the study. During the period from May 28 to June 18 the Hereford, Angus, and Brahman cows were replaced by a herd of 28 Hereford cows and one bull. The cattle were grazed on varieties of clover as growth permitted during the second period. Throughout both periods the cattle were grazed two hours each morning and two hours each afternoon.

Daily maximum and minimum air temperatures, solar radiation, and rainfall were plotted against incidence of bloat from April 21 to May 20 and from May 28 to June 17 to identify changes in one or more climatic variations with bloat incidence.

1959 Results and Discussion

The percentage incidence of bloat observed on Ladino, Louisiana S-1, and common white clovers was 70, 62, and 62, respectively. The sig-
nificantly higher percentage incidence of bloat on Ladino clover may have been associated with the rate of growth of the clover since Ladino produced considerably more forage than the others and developed very few seed heads during the study. The other two clovers were well seeded out throughout the study.

The percentage incidence of bloat in Brahman, Angus, and Hereford cows, Hereford steers, and dairy cattle was 45, 74, 68, 51, and 61, respectively. The Brahman cows and Hereford steers bloated less than the other three groups. However, in spite of the relatively low incidence of bloat in the Brahman cows and the Hereford steers, two in each of these groups died of bloat during the study. No deaths occurred in the other groups. The average percentage of bloat incidence in all groups for the morning and afternoon grazing periods was 54 and 60, respectively.

This study indicated that there are differences among clovers and breeds of cattle relative to bloat incidence. However, there is a good possibility that cattle of any breed will bloat on any of the clovers used in this study if the plants are young and in a state of rapid growth. Incidence of bloat was not significantly correlated with daily maximum or minimum air temperatures, solar radiation, or rainfall during the experimental period.

During the study one yearling Hereford steer was observed as he advanced from a number 1 bloat through numbers 2 and 3 and then to a number 4, or lethal bloat, at which time he went down and ceased to breathe. His heart continued to beat even though his tongue was cyanotic and his eyes “glassy” in appearance. A four-inch incision was made on the left side in the upper paralumbar area (flank) through the skin, fascia, and muscles and into the rumen. Intraruminal pressure (foam and gas) was released through the incision, and artificial respiration was applied until natural breathing was established and the life of the steer was saved. This phenomenon has been demonstrated during the last few years in many animals which developed lethal bloat. This illustrated that death of cattle due to clover bloat occurs because bloated cattle cannot eructate (belch), and excessive intraruminal pressure against the diaphragm prevents diaphragmatic contractions and respiration. Until this research was reported and recorded by moving pictures, many researchers explained the death of bloated cattle by the “Toxic Factor Theory” (42). This theory suggested that the death of bloated cattle was due to the production of hydrogen cyanide or hydrogen sulfide or histamine, or to the presence of flavone in the bloat-producing plants, or to an “unknown toxic factor.”

As indicated above, death of a bovine due to clover bloat results from the excessive physical pressure against the diaphragm which will not permit it to contract. Therefore, respiration is terminated and a minute or so later the heart stops beating because of anoxemia.
1960 Procedure

A. The effectiveness of two antibiotics, oleandromycin and penicillin, in the prevention of bloat was studied. Thirty-two head of yearling steers were available for the study. The cattle were Hereford, Angus, and dairy breeds. Twelve steers (Group 1) served as controls, 10 steers (Group 2) were fed penicillin in corn-and-cob meal, and the remaining 10 steers (Group 3) were fed oleandromycin in corn-and-cob meal. The penicillin and the oleandromycin were mixed with corn-and-cob meal at the rate of 50 milligrams per pound of meal. Group 1, controls, was provided one pound of meal per steer per day, Group 2 was provided one pound of penicillin meal per steer per day, and Group 3 was provided one pound of oleandromycin meal per steer per day. Each group was provided its respective meal just prior to the afternoon grazing period. The three groups of steers were grazed on clover two hours each morning and each afternoon daily for approximately one month. Each group was held in its respective holding lot between grazing periods.

B. In a concurrent experiment, rumen-fistulated cows were used to determine the effect of alfalfa hay and Ladino clover pasture on the rate of digestion of ground alfalfa hay and fresh Ladino clover in vivo. Nylon bags with alfalfa hay and nylon bags with Ladino clover were placed in rumens of cattle fed only alfalfa hay. Digestion of the contents of the nylon bags was determined at given time intervals.

1960 Results and Discussion

A. The incidence of bloat in the steers fed penicillin (Group 2) and the steers (Group 3) fed oleandromycin was not significantly different from that in Group 1 (the controls). No animals died of bloat in any of the three groups during the study. The negative results of these studies could not be explained, since previous work at this and other stations indicated that both antibiotics were bloat preventives.

B. During the first three hours Ladino clover seemed to stimulate rapid digestion of the clover in the nylon bags suspended in the rumens of cows. However, total 24-hour digestion was greatest in the nylon bags placed in the rumens of cows fed alfalfa hay. Rapid digestion of clover probably contributes to a great extent to the production of bloat.

1961 Procedure

A. A combination of antibiotics known as “Pets”6 (40 milligrams of penicillin, 70 milligrams of erythromycin, 70 milligrams of tylosin, and 70 milligrams of streptomycin per pound of pelleted feed) was tested for bloat prevention. The pelleted feed was made up of 90 per cent wheat middlings and 10 per cent molasses. The experimental cattle consisted of 44 1- and 2-year-old steers of Hereford or Angus types, three Jersey cows, and four rumen-fistulated dairy cows, or a total of 51 head.

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6Supplied by Eli Lilly and Company, Greenville, Indiana.
Three approximately equal sized pastures of Ladino clover, Louisiana S-1 white clover, and common white clover were used during the trial. Each variety of clover was further subdivided into two equal plots by means of an electric fence. The cattle were grazed two hours each morning and afternoon and held in drylot with shade, water, and salt available. Six of the animals died with lethal bloat during the conditioning period of eight days. During this time each animal was graded for bloat after each grazing period. Forty of the remaining cattle were then randomly divided into two groups of 20 head each.

The treated cattle, Group 2, were fed the antibiotic-containing pelleted feed and the control cattle, Group 1, were fed the untreated pelleted feed during the period from May 11 through June 26. Groups 1 and 2 grazed the same variety of clover each grazing period, and incidence and severity of bloat for each animal after each grazing during the experiment were recorded.

B. Four fistulated cows, two grazed on clover and two held in drylot and fed alfalfa hay, were used as host animals for nylon bags to determine dry matter digestibility and the effect of PETS on dry matter digestibility. The experiment was replicated six times. One animal of each pair was given the same pelleted feed containing PETS. Four bags of freshly plucked clover and four bags of ground alfalfa hay were placed in the rumen of each of the four cows. Bags of clover and alfalfa were removed from each cow at 1-, 2-, 4- and 24-hour periods for analysis.

1961 Results

A. The overall incidence of bloat was 37.28 per cent for Group 1 and 10.53 per cent for Group 2 for the 46-day experimental period. One steer in Group 2 refused to eat the PETS supplement at any time during the experiment, and from time to time during the experiment other steers in this group also refused to eat the PETS supplement. Three steers in Group 1 died with lethal bloat during the study but none died in Group 2. The average severity of bloat was greater in Group 1 than in Group 2. Data on Ladino clover grazing periods taken separately showed an overall per cent incidence of bloat of 49.2 and 12.3 for Group 1 and Group 2, respectively. This again proved Ladino clover was more efficient in producing bloat than Louisiana S-1 or common white clover. The steers in Group 2 (treated) gained 0.16 pound per steer per day more than did those in Group 1 (controls).

The data indicated the antibiotics did not lose bloat preventive effectiveness during the 46-day experimental period, and there was no evidence that the antibiotics had any effect on the appetites of the animals. However, it is doubtful whether cattle under practical range conditions will eat sufficient amounts of the pelleted antibiotic-containing feed to prevent clover bloat.

B. The addition of PETS to the ration of the fistulated cows reduced the dry matter digestibility of both clover and alfalfa. As was expected, there were highly significant differences in digestibility among
time intervals, i.e., among the lengths of time the bags were left in the rumens and exposed to digestive processes. The antibiotics were effective in reducing the rate of digestion of dry matter during the first four hours after being placed in the rumens. This study suggested that some fraction other than cellulose was digested rapidly when the antibiotics were not fed to the animals.

1962 Procedure

Slow-release antibiotic boluses, each weighing approximately 63 grams, were used in bloat prevention studies. The boluses contained (S) streptomycin, (T) tylosin, (E) erythromycin, and (P) penicillin (STEP).

Available cattle were conditioned to bloat for two weeks by grazing them on Ladino clover for two hours each morning and each afternoon. They were graded for bloat after each grazing period. During the conditioning phase of the study five cattle died with lethal bloat.

After the conditioning period, the 30 cattle (13 yearling steers and nine 2-year-old steers, all of Hereford or Angus types, three Jersey cows, four Holstein cows, and one Brown Swiss cow) were randomly divided into Group 1 (control) and Group 2 (treated). Each group consisted of 15 cattle. Each animal in Group 2 was administered two STEP boluses with a balling gun on May 1, 1962. None of the cattle in Group 1 were treated. Groups 1 and 2 were managed as one herd during the study, which was terminated June 5, 1962, because the clover stopped growing.

1962 Results

Three animals in Group 1 (controls) died with lethal bloat and none were lost in Group 2 (treated) during the experiment. The per cent incidence of bloat for the control cattle, Group 1, was 56.4 as compared with 10.2 for the treated cattle, Group 2. This difference was significant (P<.01).

An interesting and important aspect of the study was that four boluses were found in the holding lot the morning of May 3. Either two, three, or four animals had regurgitated boluses, which were administered May 1, after one, two, or three clover grazing periods.

Cattle in Group 1 gained 1.54 pounds per animal per day and cattle in Group 2 gained 2.26 pounds per animal per day. This was a significant difference in favor of the treated cattle.

Three animals were slaughtered approximately eight weeks after they had been administered the boluses. The boluses were found in the reticulum of each steer. Apparently the boluses were too heavy to be moved over the rumino-reticular fold into the rumen. It was surprising that the boluses had not disintegrated more. Only approximately 10 grams of each recovered bolus had dissolved in the reticula of the cattle.

7Supplied by Eli Lilly and Company, Greenville, Indiana.
1963

Research was not conducted in 1963 because climatic conditions prevented growth of clover planted in the fall of 1962.

1964 Procedure

Resistopen, a semisynthetic penicillin, which is resistant to inactivation by penicillinase and acid hydrolysis, was used to control bloat in steers grazed on Ladino clover. Twenty-six head of yearling Hereford steers were conditioned to bloat and then randomly divided so that 13 steers were used as controls, Group 1, and the remaining 13 were placed in treated Group 2. The study included conditioning, treatment, and post-treatment periods as indicated by arrows in Figure 2. During the treatment period of four weeks, the treated steers were administered 250 milligrams of Resistopen every other day by mouth in a gelatin capsule with a balling gun.

1964 Results

The average daily per cent incidence of bloat in control steers, Group 1, was 78.1. Two steers in this group died with lethal bloat during the treatment period. The average daily per cent incidence of bloat in the

![Figure 2. The effects of the use of 250 milligrams of Resistopen administered to steers via a balling gun every other day on the average daily bloat incidence in cattle grazing lush Ladino clover.](image)

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8Supplied by the Squibb Institute, New Brunswick, New Jersey.
treated steers, Group 2, was 12.9. None of the steers in Group 2 died. The difference between the results in Groups 1 and 2 was highly significant, as shown in Figure 2.

1965 Procedure

Fifty-six grade Hereford steers, identified by neck and hip numbers, were used to study the effects of poloxalene, a nonionic surfactant, on bloat prevention. The research was divided into two parts, Experiment I and Experiment II.

Experiment I was conducted to determine if poloxalene, incorporated in grain pellets and fed free choice each day, would prevent bloat in cattle grazed on Ladino clover. Fifty-three of the 56 steers were randomly assigned into three groups, and the three remaining steers were held and used for replacement purposes. Nineteen steers were assigned to Group 1 (controls), 18 to Group 2 (poloxalene-treated), and 16 to Group 3 (penicillin-treated). After the research on Group 3 was completed, 10 steers from Group 3 were selected and placed in Group 4, the poloxalene-treated, free-grazing group. Steers in Groups 1 and 2 were grazed on the same clover pasture each grazing period. Steers in Group 3 were grazed on a separate pasture, as were steers in Group 4.

Research conducted with Groups 1, 2, 3, and 4 was divided into conditioning, treatment, and post-treatment phases. Table 1 shows the number of days in each phase for each of the four groups. During the conditioning phase, Groups 1, 2, and 3 were fed placebo pellets (containing no poloxalene) at the rate of 210 grams per animal per day. Initially, steers in Groups 1, 2, and 3 were grazed two hours twice daily beginning at 6:00 A.M. and 3:00 P.M. As the treatment phase progressed, morning and afternoon grazing times for Groups 1, 2, and 3 were gradually reduced to as little as 45 minutes because of the severity of bloat. Between grazing periods, steers in Groups 1, 2, and 3 were placed in holding lots adjacent to the clover pastures, with water, shade, and salt available.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Days</th>
<th>Animal numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conditioning</td>
<td>Treatment</td>
</tr>
<tr>
<td>1. Placebo pellets</td>
<td>14</td>
<td>69</td>
</tr>
<tr>
<td>2. Poloxalene pellets</td>
<td>14</td>
<td>69</td>
</tr>
<tr>
<td>3. Penicillin</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>4. Free-grazing, poloxalene treated</td>
<td>6</td>
<td>55</td>
</tr>
<tr>
<td>5. Molasses control block</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>6. Molasses-poloxalene block</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>7. Individual consumption, molasses-poloxalene blocks</td>
<td>4</td>
<td>17</td>
</tr>
</tbody>
</table>
Throughout the treatment phase the placebo pellets were fed free choice to Group 1 at the rate of 210 grams per animal per day, and the poloxalene-treated pellets\(^9\) were fed free choice to Group 2 at the rate of 220 grams per animal per day (10 grams of poloxalene). Group 3 steers were administered 125 milligrams of procaine penicillin by capsule daily at 10:30 A.M. The steers in Groups 1, 2, and 3 were graded for bloat after each grazing period, and the steers in Group 4, the poloxalene-treated, free-grazing group, were graded for bloat once each day. Bloat induction potential of the clover was high for Experiment I.

Observations were made to determine the optimum time of the day to feed the poloxalene-treated pellets to Groups 1 and 2. Three feeding times were tested: (1) prior to morning grazing, (2) after morning grazing when all bloated animals had returned to normal, and (3) prior to afternoon grazing.

Steers in Group 4 were fed treated pellets free choice at the rate of 220 grams per animal per day at 7:00 A.M. daily.

When the respective treatment periods for Groups 1, 2, 3, and 4 were terminated, each group was permitted to continue to graze clover during the respective post-treatment periods in accordance with the established routine for each group. This further tested the bloat induction potential of the clover and the efficiency of the treatment(s).

Experiment II was organized following the post-treatment phase of Groups 1 and 2 to determine if cattle would lick salt-molasses blocks (30 grams poloxalene per 1 lb. of block) in sufficient amounts to control clover bloat. Bloat induction potential of the clover was not so high for Experiment II as it was for Experiment I.

Twenty-three steers from Groups 1 and 2 were randomly assigned to three groups. Nine were placed in Group 5 (controls) and nine in Group 6 (treated). Five of the 23 plus one additional steer were assigned to Group 7 to determine consumption of poloxalene-treated blocks by individual steers. Table 1 shows the number of days in the conditioning and treatment phases for the three groups. Post-treatment phases were not used because the clover abruptly stopped growing, due to climatic conditions, after the treatment phases were completed.

Two salt-molasses blocks without poloxalene (placebo) were placed in one holding lot for Group 5, and two poloxalene-treated salt-molasses blocks were placed in a separate holding lot for Group 6. Steers in Groups 5 and 6 were grazed together on the same clover pasture twice daily beginning at 6:00 A.M. and 3:00 P.M. Initially the two groups were grazed for two hours each morning and each afternoon, but the grazing periods were soon reduced to one hour during the treatment phase. Between grazing periods the steers (Groups 5 and 6) were held in their assigned holding lots. Steers in Groups 5 and 6 were graded for bloat after each grazing period, and Group 7 steers were graded for bloat once daily.

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\(^9\)The placebo and treated pellets were supplied by Smith Kline and French Laboratories, Philadelphia, Pennsylvania.
Each of the six steers in Group 7 was placed in a separate Ladino clover pasture of approximately 0.5 acre each. One poloxalene-treated salt-molasses block was placed in each of the six clover pastures. Each steer free-grazed clover and had access to the block in his pasture at all times. All six steers had ready access to salt, steamed bone meal, and water.

Individual blocks provided each of the three groups were weighed each day to determine the average daily consumption of each block per steer in the three groups. The placebo blocks and the poloxalene-treated blocks were replaced when necessary.

1965 Results

Experiment I demonstrated that grain pellets containing 10 grams of poloxalene per 220 grams of pellets and fed daily free choice (220 grams per steer) reduced incidence and severity (Figure 3) of bloat in steers (Group 2) permitted to graze clover twice daily. Similarly treated pellets (220 grams per steer) controlled severe and lethal bloat in steers free-grazed on Ladino clover (Figure 4). Some steers in Group 1, which were fed the placebo pellets, and some steers in Group 2, which were fed the poloxalene-treated pellets, did not eat their pellets readily every day. Steers in Group 2 which did not eat sufficient quantities of the treated pellets bloated most frequently, and three of them developed lethal bloat (Figure 3).

![Figure 3](image-url)

**FIGURE 3.**—The effects of feeding poloxalene-treated pellets on the average daily bloat incidence in cattle grazing lush Ladino clover.
Because of the high incidence and severity of bloat in the controls (Group 1, Figure 3), the morning and afternoon grazing periods; initially two hours, were reduced to 45 minutes during treatment and post-treatment phases in an attempt to maintain an adequate number of controls. Even so, 17 steers in Group 1 developed lethal bloat and it was necessary to add six steers to Group 1 (Table 1) to maintain a sufficient number of control animals.

Fourteen of the 17 steers in Group 1 and all three of the steers in Group 2 developed lethal bloat after the afternoon grazing periods during the treatment phase. This may have been due to the short interval between morning and afternoon grazing as compared with the longer interval between afternoon and morning grazing.

Only one of the three steers in Group 2 which developed lethal bloat showed signs of typical clover bloat (frothy ruminal ingesta). The other two steers had a gaseous type of bloat with no froth. It is possible these steers consumed clover too rapidly and the clover blocked the cardias, preventing eructation of gas.

Rumenotomies and artificial respirations were applied to the 21 steers which developed lethal bloat (one case occurred before the steers were randomly divided and assigned to groups) and 18 were saved. However, two of the 18 died with acute peritonitis within two weeks after treatment, and a third died approximately six weeks after treatment.

On day 40 of the experiment, placebo pellets were fed by mistake (Figure 3) to Group 2 and the poloxalene pellets were mistakenly fed the steers in Group 1 (control). This error showed how quickly poloxalene would control clover bloat in untreated cattle which had been bloating consistently for several weeks. The relatively low incidence and severity of bloat in Group 2 steers on day 40 indicated that there was some carry-over effect of poloxalene from the previous day. Control of bloat in Group 2 was quickly established on day 41 after the steers consumed the poloxalene pellets. Bloat incidence and severity in the control steers, Group 1, increased quickly after feeding of placebo pellets was resumed on day 41.

The results with Group 3 steers (penicillin-treated) demonstrated that penicillin will control clover bloat in cattle for only a brief period (Figure 4).

The 10 steers in Group 4, the free-grazing group, consumed poloxalene pellets for two days before activation of their treatment phase. These steers were selected from Group 3 because they ate the poloxalene-treated pellets readily each day. They maintained a very good fill of clover every day during the 55-day treatment phase.

Differences in grazing management did not permit comparing Group 4 with any other group. Due to the bloat-producing qualities of the clover, shown by Group 1, a control group could not be used because of the probability that all untreated control steers would have developed lethal bloat within a few days. However, the experiment with Group 4 showed that poloxalene is effective (Figure 4) in preventing severe or lethal bloat in cattle free-grazed on Ladino clover with high bloat in-
duction potential. The post-treatment phases for Groups 1, 2, 3, and 4 showed bloat induction potential of the clover was high (Figures 3 and 4) throughout Experiment I. The effectiveness of poloxalene treatment in Groups 2 and 4 was also demonstrated. Penicillin, Group 3, had lost its effectiveness (Figure 4) before the post-treatment phase for this group was initiated.

Analysis of variance of the data from Groups 1 and 2 indicated that the differences between grazing times and treatments for both incidence and severity of bloat were significant (P<.01). In Group 1, the percentage incidence of bloat averaged 90.5 and the average severity score was 1.90. By comparison, the percentage incidence of bloat in Group 2, poloxalene-treated, was 27.4 and the average severity score was 0.43.

Differences in daily incidence of bloat between Groups 1 and 2 were not significant, but differences in severity relative to time of feeding the pellets were significant (P<.01). The study involving Groups 1 and 2, admittedly unorthodox, indicated that prior to morning grazing was the most desirable time to feed poloxalene pellets.

Experiment II showed that poloxalene-treated salt-molasses blocks (30 grams poloxalene per 1 pound of block), offered free choice, controlled incidence and severity of bloat in steers (Group 6) grazed on clover twice daily. The poloxalene-treated blocks, offered free choice, were more effective in controlling bloat in individual steers (Group 7) which were free-grazed on clover than they were when offered to steers

![Graph](image-url)

**FIGURE 4.**—Effects of feeding poloxalene-treated pellets on the average daily bloat incidence compared with penicillin; also the comparison of the persistency of the two treatments in cattle grazing lush Ladino clover.
managed as a group and held in drylot between clover grazing periods (Group 6).

Because of the high incidence of bloat in the control steers (Group 5) and the severity of bloat in some of these steers, it was necessary to reduce the initial morning and afternoon grazing periods for Groups 5 and 6 from two hours to one hour to prevent some steers in Group 5 from developing lethal bloat.

Groups 5 and 6 each had a total of 306 opportunities to bloat. None of the steers in Groups 5 or 6 developed lethal bloat, but there were 47 cases of number 3 bloat in the control steers (Group 5) and only five cases of number 3 bloat in the treated steers (Group 6). Group 5 had a total of 207 cases of number 1 and 2 bloat compared with a total of 65 cases of number 1 and 2 bloat in Group 6. Differences between Groups 5 and 6 for average daily incidence and severity were significant (P<.01).

Control Group 5 consumed an average of 1.5 pounds of placebo block per animal per day and Group 6 consumed an average of 0.9 pound of poloxalene-treated block per animal per day.10

Group 7 was free-grazed, and none of these steers bloated during the treatment phase. However, one steer in this group did not consume any of his block on one day of the experiment. Apparently there was a carryover effect of the poloxalene from the preceding day in this steer. Individual consumption of the poloxalene blocks (Group 7) varied from 0 to 1.8 pounds per animal per day, and the average daily consumption of the poloxalene blocks by the six steers in Group 7 varied from 0.61 to 1.19 pounds per animal per day, or from two to almost four times the required daily amount of poloxalene (10 grams per steer) to control bloat.

Experiment II indicated that animals free-grazed on Ladino clover will consume more than the necessary amount of poloxalene to control bloat if it is provided free choice in salt-molasses blocks containing 30 grams poloxalene per pound of block.

1966 Procedure I

A field trial study using poloxalene-treated salt-molasses blocks, 30 grams per pound of block, was conducted in the spring of 1966. Four herds of cattle (a total of 144 head) and pastures provided by cattlemen near Hamburg, Louisiana, were used. Initially each herd was grazed on a separate pasture of “Nolin’s Improved Louisiana White Clover,” and each herd was provided treated or untreated blocks in covered troughs free choice. The treated blocks were periodically replaced with untreated blocks to determine the bloat induction potential of the clover in three of the pastures during the experiments. The blocks were provided at the approximate rate of one per four head of cattle and were weighed every day by a representative of the Louisiana Agricultural Experiment Station except for two days during the experimental period. New blocks

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10 Treated and untreated blocks were supplied by A. E. Staley and Company, Decatur, Illinois, for the 1965 and 1966 experiments.
were added to each trough after approximately 60 per cent of the initial weight had been consumed.

Each animal in each of the four herds was observed during the morning and afternoon, except for the two days previously mentioned, and incidence and severity of bloat for each animal were recorded.

Herd 1 included 60 long yearling heifers, some of which had been bred; 15 calves were born during the experimental period. Most of the heifers were Herefords, but the group included a few Shorthorns and Santa Gertrudis crosses. The pasture for this group was approximately 85 acres including about 20 acres of woods. The quantity and quality of clover available were very good throughout the trial. There was very little palatable grass in the pasture.

Herd 2 consisted of 33 mature cows, a few of them with fall calves. Most of the cows were Herefords. They were initially placed on a seven-acre pasture of excellent white clover, but within two weeks the pasture was overgrazed and no longer capable of inducing bloat. Near the end of the experimental period this group was shifted to a pasture of about 40 acres, which was predominantly Persian clover and which was adjacent to about 20 acres of woods.

Herd 3 consisted of 25 mature Hereford cows, two of which calved during the experimental period. The pasture was approximately 25 acres, included one shade tree, and consisted of a white clover-ryegrass mixture. The clover predominated early in the trial but later there was sufficient ryegrass to limit bloat induction.

Herd 4 consisted of 25 mature Hereford cows and one Shorthorn. Three cows calved during the trial and one of these was removed from the experiment because of mastitis. The pasture contained about 25 acres with one shade tree and had been newly seeded to white clover and fertilized. Clover quantity and quality were extremely good throughout the trial.

1966 Results 1

Herd 1, 60 long yearling heifers, was placed on lush white clover March 19, 1966, with placebo blocks available until the afternoon of March 21, when the placebo blocks were replaced by treated blocks and control of bloat was obtained. However, an increase in bloat incidence occurred on March 23, because of a change in the grazing pattern of the herd. This made it necessary to add an additional trough with blocks. Because of the shape and size of the pasture (80 acres) it was necessary to provide four covered feed troughs with blocks to ensure opportunities for every animal to lick the blocks daily. On April 2 the heifers were penned five hours for weighing purposes, and within two hours after they were turned back to pasture, one died with number 4 bloat. Figure 5 shows the relatively low incidence of bloat for Herd 1. The increase in bloat during the two 48-hour control periods initiated on April 3 and April 24 (Figure 5) indicated the bloat induction potential of the clover.

Herd 2, composed of 33 mature cows, was placed on pasture April 2, 1966. Poloxalene controlled bloat in these cattle for about two weeks
while they were grazed on seven acres of excellent white clover. On April 26 they were moved to a Persian clover pasture for a short time and treated blocks were used to control bloat.

Herd 3, composed of 25 head of mature Hereford cows, was placed on a pasture of white clover-ryegrass mixture March 22, 1966. After approximately two weeks the ryegrass became dominant. One trough with blocks was initially located close to the water trough in this pasture. During this time the cattle consumed but small quantities of the blocks and bloat incidence in the herd increased. Figure 6 shows that prevention of clover bloat was obtained after March 25, when the trough was moved to a location under a lone shade tree where the cattle congregated when resting. The incidence of bloat during the 48-hour control period initiated April 13 (Figure 6) indicated the bloat induction potential of this pasture was not comparable to that of pastures grazed by Herds 1 and 4 (Figures 5 and 7).

Herd 4, 26 mature Hereford cows, was placed on clover March 22, 1966. The pasture consisted of 25 acres of first-year clover. One trough with treated blocks was initially placed near the water trough, but after five days it was relocated under a lone shade tree in the pasture. During the first five days of this trial the cattle did not consume enough of the treated blocks to prevent severe bloat, but bloat incidence and severity were low for some unknown reason(s). However, the first control period,

![Figure 5](image_url)

**Figure 5.**—Effects on the average daily bloat incidence of poloxalene-treated salt-molasses blocks provided cattle grazing good clover-grass pasture under range conditions.
which was initiated April 12, was terminated 12 hours before the 48-hour control period was completed due to the high incidence and severity of bloat (Figure 7). During this 36-hour control period 21 cases of bloat were observed, with six being moderate to severe (numbers 2 and 3 bloat). For some unknown reason(s) the cattle consumed inadequate quantities of the treated blocks from April 15 to April 18, and bloat incidence increased. On April 18 the cattle voluntarily started to con-
sume the treated blocks in sufficient quantities and prevention of bloat was again established. The relatively low bloat incidence during the second 48-hour control period, which was initiated April 27, indicated the bloat induction potential of the clover had decreased.

Table 2 shows the total cow days on poloxalene, the amount consumed by each herd, and the average daily consumption of each cow. The overall average of 0.71 pound of poloxalene-treated block per cow per day is more than twice the amount needed to prevent severe or lethal clover bloat in cattle.

Table 3 shows the body weight gains of Herds 1, 3, and 4. It also gives a comparison of average daily body weight gains per cow per day in Herds 3 and 4. Herd 3 grazed a very good ryegrass-clover pasture which was predominantly ryegrass, while Herds 1 and 4 grazed very good pastures which were predominantly clover.

<table>
<thead>
<tr>
<th>Herd</th>
<th>Cow days on poloxalene</th>
<th>Total consumption of blocks with poloxalene (lb.)*</th>
<th>Average daily consumption/cow (lb.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd 1</td>
<td>2313</td>
<td>1459.6</td>
<td>0.63</td>
</tr>
<tr>
<td>Herd 2</td>
<td>750</td>
<td>868.0</td>
<td>1.16</td>
</tr>
<tr>
<td>Herd 3</td>
<td>975</td>
<td>665.1</td>
<td>0.68</td>
</tr>
<tr>
<td>Herd 4</td>
<td>946</td>
<td>554.2</td>
<td>0.59</td>
</tr>
<tr>
<td>TOTAL</td>
<td>4984</td>
<td>3546.9</td>
<td>0.71</td>
</tr>
</tbody>
</table>

*30 grams of poloxalene per pound of block.

Table 3.—Liveweight Gains While Grazing Clover, 1966

<table>
<thead>
<tr>
<th>Herd</th>
<th>Number of animals</th>
<th>Days between weighings</th>
<th>Avg. initial weight (lb.)</th>
<th>Avg. final weight (lb.)</th>
<th>Avg. gain per day (lb.)</th>
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</thead>
<tbody>
<tr>
<td>Herd 1</td>
<td>50</td>
<td>34</td>
<td>653</td>
<td>722</td>
<td>2.03*</td>
</tr>
<tr>
<td>Herd 3</td>
<td>25</td>
<td>32</td>
<td>984</td>
<td>1,022</td>
<td>1.19**</td>
</tr>
<tr>
<td>Herd 4</td>
<td>26</td>
<td>32</td>
<td>894</td>
<td>976</td>
<td>2.56***</td>
</tr>
</tbody>
</table>

*This disregards 15 calves dropped during the period. If their weight is added to the final weight of their dams, average daily gain becomes 2.77 lb/day.

**This disregards two calves dropped during the period.

***This disregards three calves dropped during the period.

1966 Procedure II

Thirty-five yearling Hereford steers were used to determine if *Clostridium perfringens* type E and D toxoids would prevent clover bloat in cattle which had been administered the toxoids. Group 1 consisted of 15 control steers which were not inoculated with toxoids. Group 2 consisted of 10 steers each of which was inoculated with five milliliters of type C and five milliliters of type D toxoids subcutaneously on March 11, 1966. The 10 steers in Group 3 were each inoculated with five milliliters of type C and five milliliters of type D toxoids subcutaneously on March 11 and again the morning of April 21, 1966. All steers in the three groups were grazed on the same clover plot for two hours each morning and
two hours each afternoon for nine days. Each steer was observed for bloat incidence and severity after each grazing period and the data were recorded.

1966 Results II

Some of the steers in each group started to bloat three days after they were initially placed on the clover, and four days later incidence and severity of bloat in the three groups showed that the toxoids did not prevent bloat. During the experimental period of nine days there was a total of four cases of severe bloat (number 3) in Group 1 (controls), three in Group 2, and three in Group 3. However, no cases of lethal bloat (number 4) occurred in any group. The maximum per cent of steers that bloated in Groups 1, 2, and 3 during the experimental period was 60, 44, and 70, respectively. Nine days after the steers were placed on clover they were provided poloxalene-treated salt-molasses blocks free choice at the approximate rate of one block per four steers. This reduced the severity and incidence of bloat and prevented induction of severe or lethal bloat in all of the experimental steers until the clover quit growing the first week in July.

1967 Procedure

Thirty-four yearling Hereford steers were employed in an experiment to learn if Clostridium perfringens type D bacterin would prevent clover bloat in cattle which had been vaccinated with the bacterin. Fourteen steers were placed in Group 1, the untreated controls. Each of the 10 steers in Group 2 was inoculated subcutaneously with five milliliters of the bacterin on March 23, 1967. Each of the 10 steers in Group 3 was administered five milliliters of the bacterin subcutaneously on March 23 and again on May 20, 1967. The 34 steers were placed on clover the afternoon of May 27, 1967. The steers were grazed on the same clover pasture for periods ranging from 30 minutes to two hours each morning and afternoon for 18 days.

1967 Results

The incidence of bloat increased significantly after the first five grazing periods in all three groups of steers. However, no cases of lethal bloat occurred in any of the three groups, but there were five cases of severe bloat (number 3) in Group 1, nine in Group 2, and three in Group 3. Clostridium perfringens bacterin type D did not prevent the treated steers (Groups 2 and 3) from bloating. The maximum incidence of bloat in each of the three groups occurred on the last day of the experiment, May 14, 1967. Eighty per cent of the steers in Group 1 bloated, as did 95 per cent of those in Group 2 and 66 per cent of those in Group 3. Poloxalene-treated salt-molasses blocks were provided free choice from May 15, 1967, through the second week in July to control severe and lethal clover bloat in the experimental cattle. The blocks were provided at the approximate rate of one block per four steers.
**Literature Cited**


