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SOUTH DAKOTA *Farm and Home* RESEARCH

proper fertility helps corn yield more, grow better systems under limited moisture, see page 3

SOUTH DAKOTA
Farm and Home RESEARCH
a report of progress

Volume XI May 1960 Number 3

FIELD DAY DATES SET

Dates for 12 Field Days are shown on pages 16 and 17. These days are planned for you. The research scientists who study farm and ranch problems will be on hand to discuss their work with you. Studies are underway at many locations throughout the state, as well as at Brookings. As a result, the work is tailor-made for problems in the various areas.

You can also discuss any individual farming or ranching problems with the scientists during the Field Days in your area.

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SOUTH DAKOTA FARM AND HOME RESEARCH will be sent free to any resident of South Dakota in response to a written request to the Experiment Station Editor, South Dakota State College, College Station, Brookings, S. Dak.

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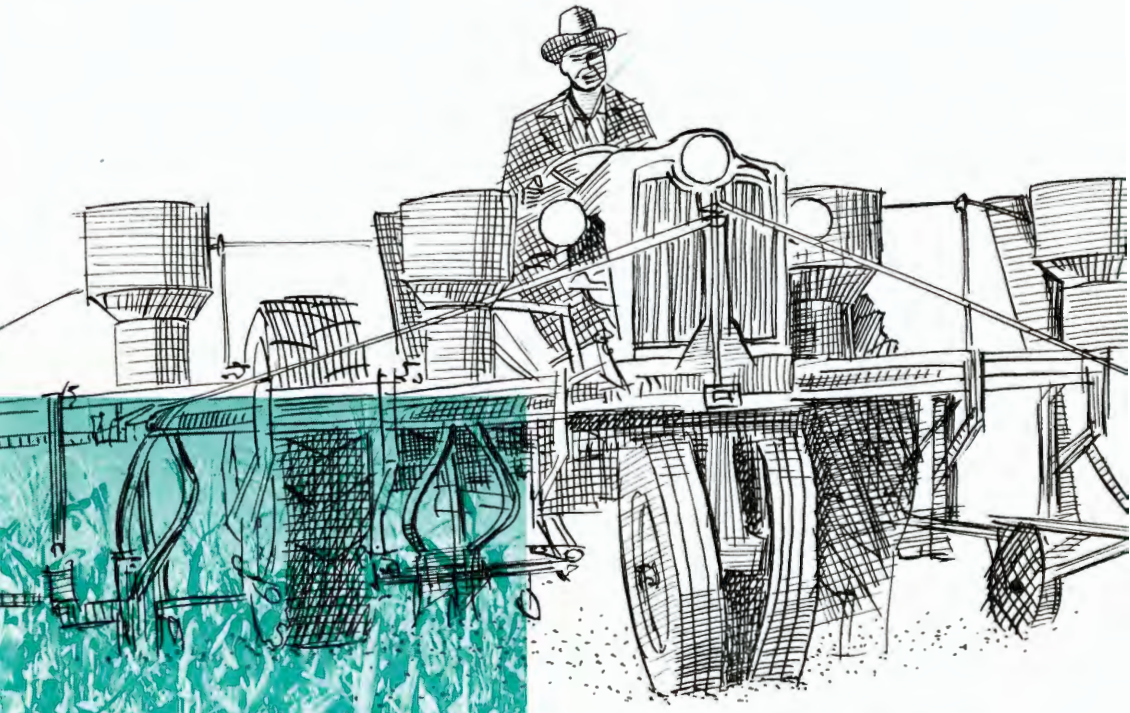


fertility helps corn yield more, grow better root systems under limited moisture

By Paul Baxter and L. O. Fine

THE EFFECT OF increased soil fertility on the impact of drought has caused some widely different opinions to be developed among farmers, soil technicians, and the fertilizer industry. Results that indicate different effects of fertilizer under various conditions have been obtained by Experiment Stations in the Midwest. Because subsoil moisture varies under different types of drought, we decided to investigate

effects that certain fertility practices might have on drought injury of crops.

Field experiments were conducted in 1955 and 1956 in Hand, Hyde, and Spink counties to evaluate the way that crops react to increased nitrogen fertility under limited moisture. In both years there was some plant-available moisture in the subsoils of the experimental sites at planting time. Thus, the type of drought was one in which there was initially some subsoil moisture. A stringency developed during the growing season.

The greatest water efficiency (bushels of grain per inch of water used) was obtained with barley fertilized at 80 pounds of nitrogen per acre in a barley experiment on La-Delle silty clay loam in 1956. However, extreme heat with temperatures of 104° to 111° in June of 1956 reduced the usefulness of small grain experiments conducted that year.

An experiment with corn was conducted in Hand county in 1956 on a loam soil. This soil possesses a slight, but definite, plow sole at about 6 inches. At this depth there was also a definite transition to a layer of soil of lower organic content than the surface. A side-dressed fertilizer experiment was placed on this corn (planted in 40-inch rows) when the corn was 18 inches high (July 1). The rates of application of nitrogen were 0, 40, 80, 160, and 320 pounds of actual nitrogen per acre. The material used was ammonium nitrate. All treatments were replicated four times. At harvest time, corn grain yields on all plots and soil moisture contents of the zero and 40 pound nitrogen treated plots were determined, to a depth of 4 feet. The results of the moisture and yield determination are given in the table.

Yields of Corn and Moisture Content of the Soil on Variously Treated Fertilizer Plots. All Data Are Averages of 4 Replications.

Nitrogen applied, lbs./A	Yields, bu. per A	In. water above wilting point at harvest. (Surface to 4 ft. depth)*
0	32.1	0.57
40	45.6	—0.18*
80	44.3	------
160	42.2	------
320	42.9	------

*Water in the 4 foot soil profile was measured as that held at lower energy values or tension than the "15 atmosphere" tension value. The negative value here indicates that the corn was able to extract moisture below the 15 atmosphere or "laboratory value" wilting percentage.

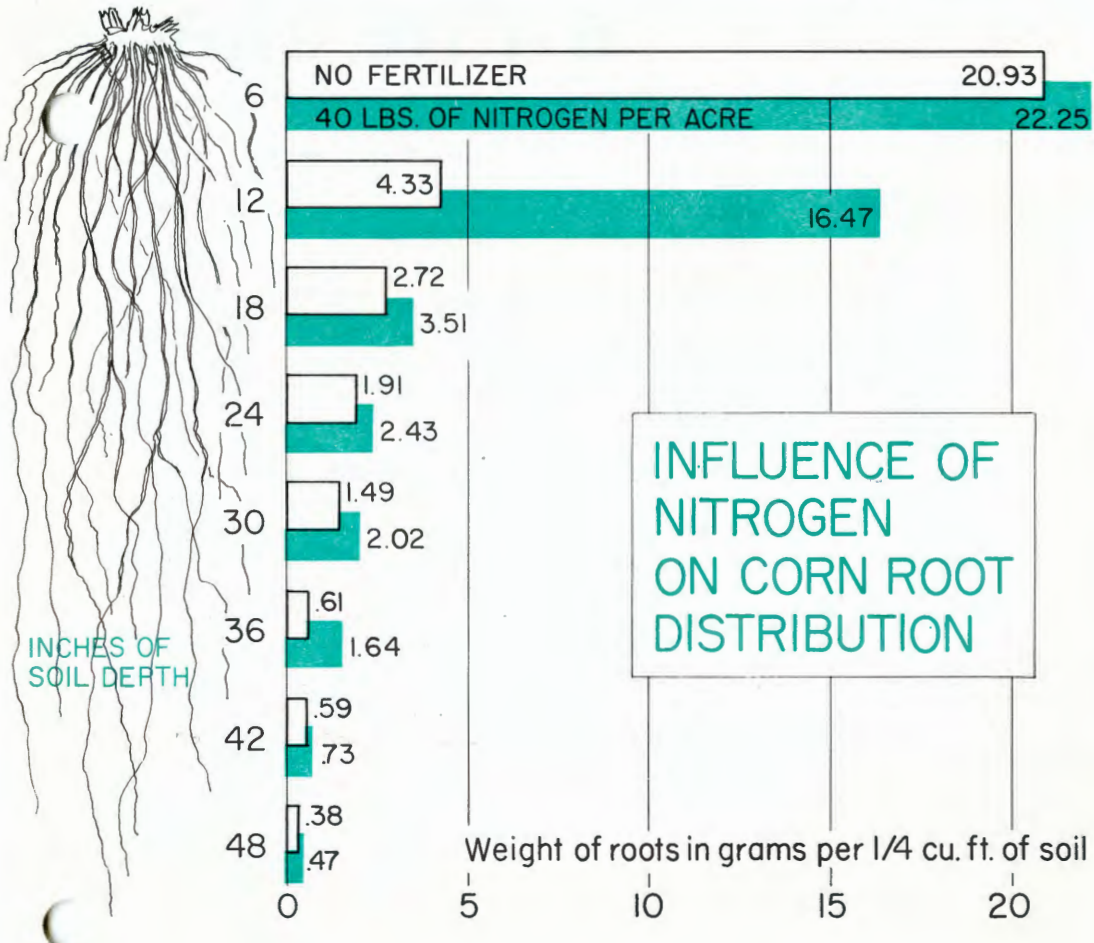
The rainfall of the 1956 growing season was 0.98, 1.78, 4.55, 3.83, 3.30, and 0.30 inches per month in April through September, inclusive. Although a total of only 7.43 inches fell in the growing season after the fertilizer was applied, and in spite of the fact that the profile was "dry" at the end of the growing season, no significant yield reduction resulted from fertilizer application. It is also significant that 0.75 inches more water was used from the 4-foot soil profile where 40 pounds of nitrogen were applied than where no nitrogen was used.

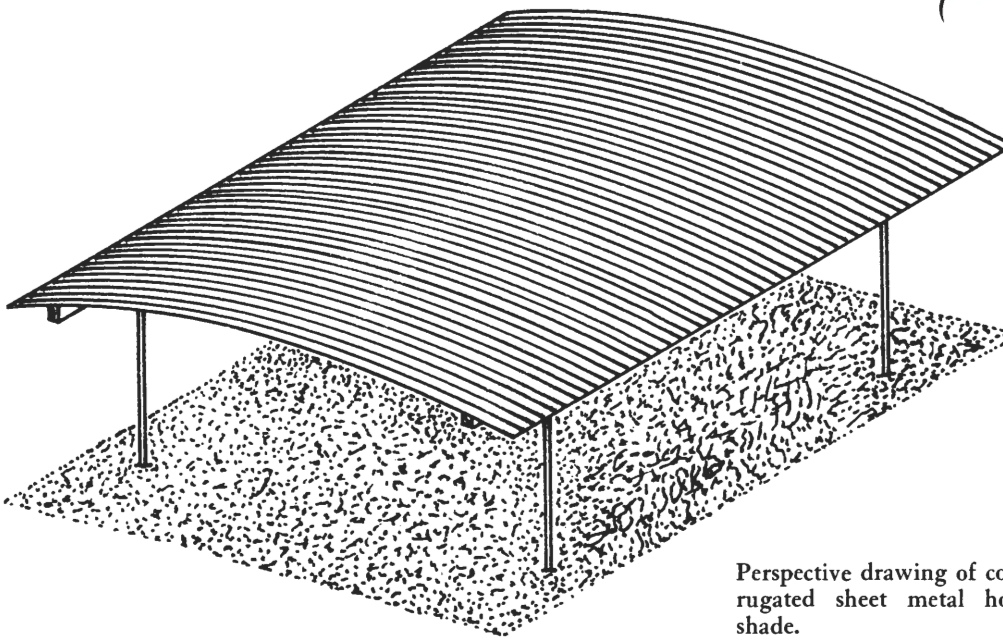
The root distribution of corn to the 4-foot depth was determined by excavating to expose the soil profile, cutting a section of soil 6 inches thick, 40 inches wide, and 48 inches deep, enclosing it in a rectangular

frame, moving the frame to a water supply, and washing the soil away until the roots could be separated and weighed. The weights of corn roots found at the various depths are presented in the figure.

The total weight of roots below the 6 inch soil depth was more than twice as great in the fertilized as in the unfertilized soil. The amount of root development in the 6 to 12-inch soil depth was about 4 times as great in the fertilized as in the non-fertilized plot. This greater root development supported a somewhat larger corn plant and produced a larger ear. It also resulted in the use of 0.75 inches more moisture to the 4-foot depth from the soil reservoir, and about 13 bushels more corn per acre.

It appears that in this type of drought, in which some subsoil moisture was present at the beginning of the growing season, and a moisture stringency developed as the season progressed, an adequate supply of nitrogen helped remarkably in developing a greater root system, making fuller use of the available water present, and producing a higher yield. In this experiment, nitrogen additions up to 320 pounds per acre, applied as a side-dressing about July 1, had no deleterious effect on yield, but produced no yield increase over the 40 pound application. (Project 173 Agronomy Dept. Grateful acknowledgement is hereby made to the Phillips Petroleum Company for financial assistance in this project.)





Perspective drawing of corrugated sheet metal hog shade.

NEW DEVELOPMENTS IN swine shades

By Charles N. Hinkle and Harvey G. Young

A SHADE OR FIELD SHELTER in a pasture rotation system for handling swine should be portable to be effectively used. In its true sense, the word "portable" is closely related to the word "carry"; something which is portable can be carried. Most plans for portable hog shades call for material such as 4 x 4's or 4 x 6's for skids, 4 x 4's for posts, and a collection of framing lumber for ties, braces, supports, and reinforcement. All of this still has to be topped by the covering material which does the actual shading of the area below. This common type of shade thus becomes difficult to carry, both physically and financially.

Some type of shading device is needed to protect pigs, especially the heavier ones, from the direct heat load of the sun. We wanted to find a way to provide this shade with some type of portable cover without using all the heavy timber underframing of the current swine shade plans.

The shades tested were all unique in design, lightweight, and economical in construction. All of these shades were portable or easily moved. The shades could be dismantled to several components and placed on a truck or other flat-bed type of carrier for moving from one location to another or moving undercover for winter storage.

Tests have been conducted dur-

ing the past two summers to see how long the various shade shelters would last. For the most part these shades consisted of lightweight roof frames attached to steel fence posts.

Galvanized sheets and black polyethylene were used for the roof coverings. The black polyethylene coverings were of 4- and 6-mil thickness. A special 10-mil thickness which was laminated with a white underside and a black top was also used. It was difficult to keep the 4- and 6-mil polyethylene coverings from tearing during the two summers of use. These plastic covers were particularly susceptible to wind damage which caused the corners and edges of these sheets to work loose from their fastenings. Repairs were required every few days on most of the plastic covered shades and immediate repair was necessary to prevent the entire cover from being torn from the frame.

The heavier 10-mil experimental plastic proved to be much more durable than the lighter weight plastic. It was not damaged by wind action and rain did not accumulate in pockets formed between supports to the extent of the conventional polyethylene. The cover remained serviceable during the summer test without requiring any maintenance. Because of the susceptibility of the 4- and 6-mil polyethylene to wind damage, it is not recommended for hog shades in South Dakota.

Metal Roofing Most Successful

One of the most successful shades was that which used corrugated sheet metal roofing in an arched form as the covering material (see drawing). This shade was constructed by setting steel posts at the corners of a 8- by 9-foot rectangle. The posts were driven into the ground at an angle so that the top of the post sloped outward approximately 6 inches, thus forming a rectangle 8 feet by 10 feet. Two 2 x 4's twelve feet long were used as the support members for the corrugated roofing. They were fastened to the post top using a hook bolt wrapped around the steel post and passing through the 2 x 4 with a nut and a washer.

Twelve-foot lengths of corrugated sheet metal were then laid across the tops of the 2 x 4's and nailed in the valleys to the support members using double headed nails or scaffold nails approximately 5 inches on center. Both new and used metal sheets were satisfactory. After the corrugated metal sheets were nailed in place, four loops of number nine wire were looped around the two 2 x 4 side members and spaced uniformly along their length. The loops were tightened by twist-

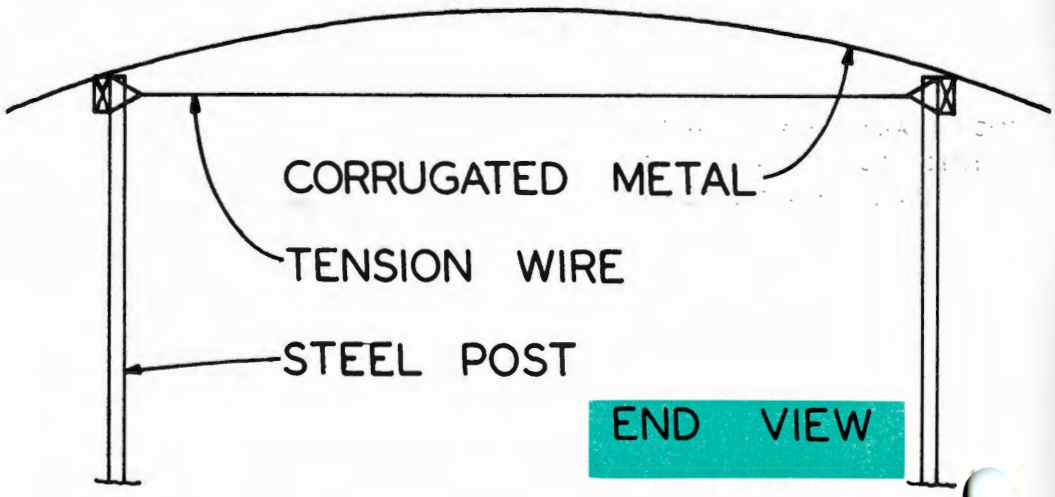
HOGS NEARING MARKET WEIGHT NEED PROTECTION FROM THE SUN DURING THE SUMMER

ing until the corrugated sheets arched to a height of approximately 1 foot in the center and the steel posts originally driven at an angle were vertical. The sheets were arched primarily to give rigidity to the shade frame rather than moisture shedding ability as their appearance might indicate.

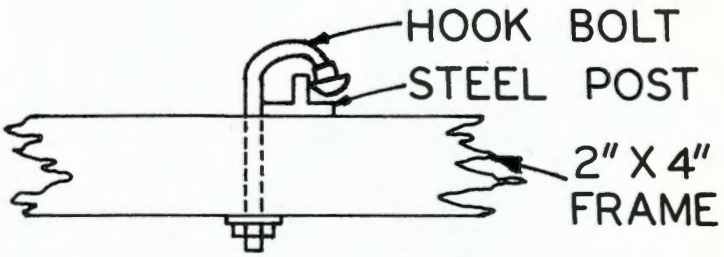
The arched corrugated sheet metal shades proved very durable with the exception of one that was damaged by wind shortly after it was erected. One section of the sheet metal was torn loose by the wind and bent considerably. This could have been prevented by using small washers under the nail heads. Except for this instance, the shades required only occasional tightening of the tension wires due to normal wear.

To move these shades to another location or to dismantle them for winter storage, we just loosened the four nuts on the hook bolts attaching the 2 x 4 frames to the steel posts. The roof was then lifted from the posts and the posts pulled from the ground and moved to the new position. The roof was then set back on top of the posts without any additional tightening of the wires. For winter storage it might be desirable to loosen or remove the tightening wires so that the sheet metal attached to the boards could be stacked in a flat position in the barn or possibly stored vertically against some wall. Light weight roof frames should be stored during the winter months.

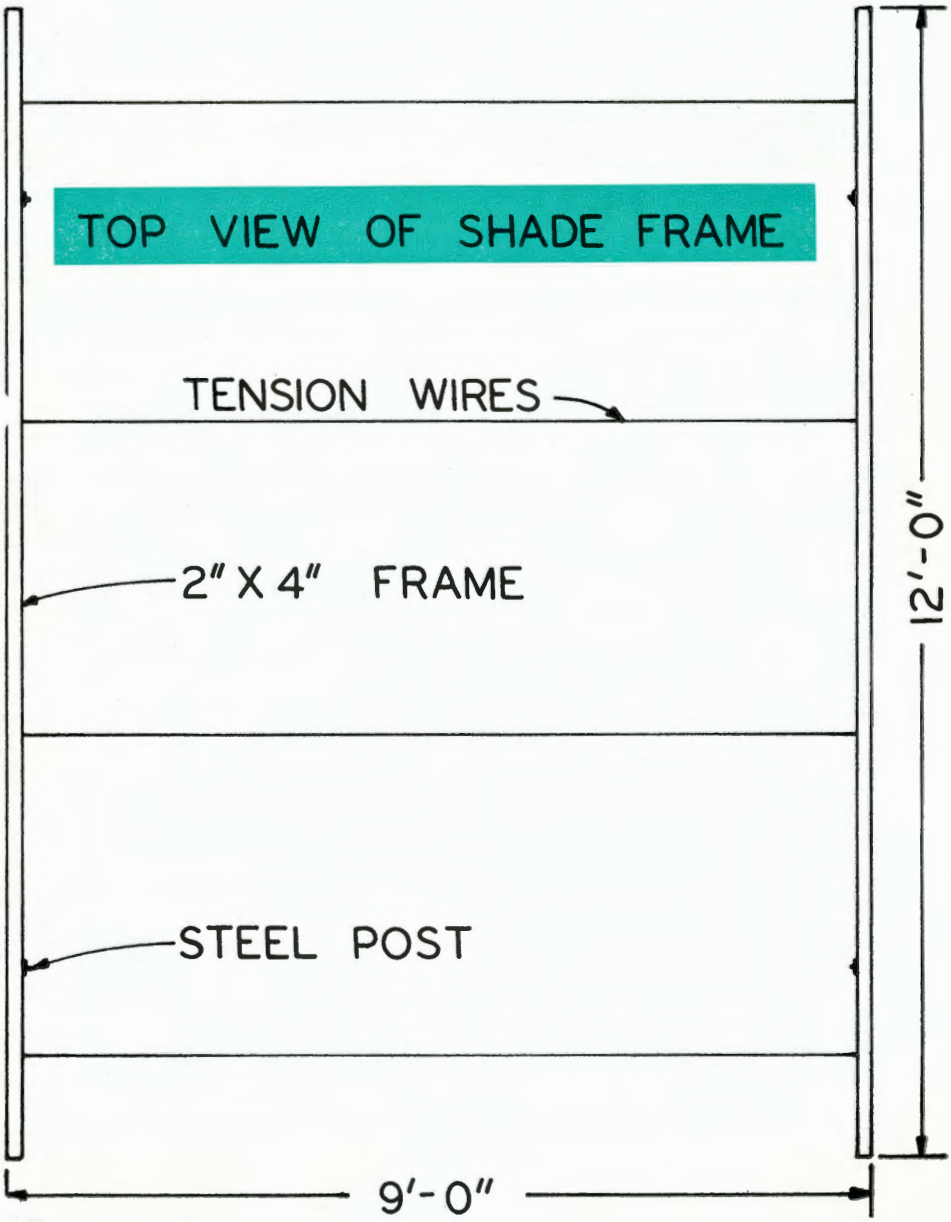
A factor that had considerable bearing on the use of the shades during this test was the size of the animals in the pens. Hogs ranging up to 75 pounds in weight indicated very little need for shade and quite often could be found grazing during the hottest part of the day. The heavier young hogs required shade during the hottest part of the afternoon and checks of the area would find them resting in the shade or seeking relief in mud holes created by rain and water spilled from the waterers. The mature animals were much more intolerant to warm weather and would spend the greater portion of the daylight hours under the shade. In all cases where the shades were in constant use, the hogs had a tendency to make wallows in the shaded area. During dry weather the wallows became extremely dusty and we had to relocate the shade. (Project 316, Agricultural Engineering Dept.)



SHADE SUPPORT DETAIL



TOP VIEW OF SHADE FRAME



ponderosa pine for Christmas trees

By Paul E. Collins

THE CHRISTMAS TREE industry nationwide is big business. Last year some 40 to 50 million trees were sold in the United States. It has been estimated that about 200,000 trees are sold in this state. This means that upwards of half a million dollars is shared by retailers, wholesalers, and growers to place a Christmas tree in our homes for the yuletide season.

Most of our Christmas trees are imported from other areas. The bulk of the imports are Douglas-fir, cut from forest lands of Montana. Probably less than one-fourth of the market is shared by black spruce and balsam fir from Canada and Minnesota and various kinds of plantation-grown pines from states to the east of us. Only a few of the Christmas trees are locally grown. Some Ponderosa pine and spruce are cut and sold locally in the Black Hills area, and a few nurseries sell spruce and pine trees.

Some interest has been generated in recent years to establish plantations in our state. The interest has been primarily an economic one. First, there appears to be a ready market for plantation-grown trees near population centers. Second, it is an enterprise that qualifies under the tree-planting provisions of the conservation reserve. Third, it offers a new crop for diverted acres. Finally, on paper, it appears to offer a high income return per acre with little or no anticipated costs of production. Some have the erroneous idea that the trees need only to be planted; after that the trees can be forgotten until harvest time.

Very little consideration has been given to what kind of trees can be grown and their site requirements. Little or no attention has been given to the cultural needs of Christmas trees during the growing period.

What species are used in Christmas tree plantations? Eastern states have gone largely to pines. These include jack, red, Scotch, and white. Douglas - fir, Eastern redcedar, and spruces are also planted. The longer needled pines have found ready acceptance by the consumers. High quality red pines command premium prices. Of the species

mentioned, only Eastern redcedar and white spruce are adapted here. It is likely that certain seed sources of Scotch pine and Douglas-fir will do all right on specific sites. Our counterpart to red pine, a long-needled tree, could be Ponderosa pine. In the last few years, some study has been undertaken here to learn more about its potential as a Christmas tree in South Dakota.

The trees available for study were not planted for this purpose. Close spacing in the row prevented full development of all side branches. However, careful thinning and pruning has made it possible to bring some of the trees to saleable size and quality. The trees were planted in 1949. About half of the trees had attained or exceeded the 6-7 foot class by 1958. Prior to that time about a dozen had been harvested each year beginning in 1954, though not all had reached 5 feet in height when cut. This indicates that about ten growing seasons will be required to produce a marketable size. Also implied is the need for selective cutting over a period of years rather than a single clearcut operation.

The few Scotch pine in the plantation developed more rapidly. The latter species begins to put on height growth much more quickly than Ponderosa pine. Ponderosa often requires 3 or more growing seasons before any appreciable height growth takes place. To a Christmas tree farmer, this can be quite a disadvantage.

When appreciable height growth commences in pines, it normally proceeds too fast. If left unchecked, the tree becomes too thin. Pines develop new branches only at the terminal end of the current year's growth. The lateral buds develop only as clusters around the terminal bud. As the terminal bud unfolds to produce the upright candle, the lateral buds open and form a whorl of branches at the base of the candle. Pruning must be done to reduce the distance between the branch whorls. In effect, height growth of the tree must be held to tailored proportions, usually 12-15 inches annually.

Timing is important in pruning. In our area mid-June pruning has given the best results. By this time candle elongation is normally complete. The pruning cut is made at the desired height. New side growth, too, requires cutting back to the general shape of tree desired. New buds usually form at or near the cut end if pruning is timed to this period. If pruning is delayed until late summer or fall little

Ponderosa pine planting located at Brookings.

or no bud formation will take place for next year's growth. As a result, height growth may be delayed for a year or new growth will be sparse, with the development of a crooked central stem.

Ponderosa pine has shown erratic response to pruning. New buds usually form at the cut terminal end, but side branches often fail to do so. Since it has been erratic in this respect, a certain percentage of trees will fail to develop into high quality trees. However, they can still be used as boughs and other greenery. The few Scotch pine in the planting have responded very well to pruning.

Insects and diseases have not been a serious problem in this planting. However, some trouble here should always be anticipated since there are potential troublemakers. Protection of the planting from fire, livestock, and rodents is a must.

As in windbreaks, cultivation to control weeds is also a must. Not only is weed control a water conservation measure, but control means earlier commencement of height growth and prevention of killing the small pines or shading out of lower branches. A spacing of 6x6 feet is probably the minimum required for good side branch development. At this spacing slightly over 1,200 trees per acre can be planted.

Light soils seem to offer the best prospect for Christmas tree growing. If the land slopes to the east or north the chances of success are improved. Wind erosion on such soils may be a problem, depending on exposure.

What are the qualities of Ponderosa pine for Christmas trees? In the last 2 years, trees have been furnished to the College Horticulture-Forestry Club for campus displays. The first year, questionnaires were provided at each location to sample the student, faculty, and employee reaction.

Of the more than 275 forms completed, 75% rated the general appearance of the trees as excellent. Such characteristics as density and needle retention rated the highest. Foliage color, needle length, and shape were also rated favorably.

Only 10% felt that Ponderosa pine was a poor Christmas tree. Those who rated it excellent were lavish in their praise. Those who rated it low were equally vociferous in their comments. This points up the importance of tradition and emotion in choosing a Christmas tree. It must be pointed out that this was essentially a young consumer group. As has been stressed in other Christmas tree studies, younger families are more inclined to accept long-needled trees, whereas older-aged groups tend to stick by traditional types. Also, sampling was not accomplished systematically, and the results can be judged only as indicative of a select consumer group's opinion.

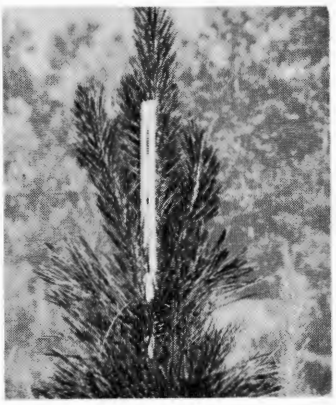
Ponderosa pine has excellent needle-retention qualities. By proper pruning, premium trees can be grown of good symmetry and density. In most years the color is good, although there is a chance that some yellowing will occur by Christmas time. The trees tend to give off a resinous odor which may be judged pleasant or objectionable, depending upon individual likes

and dislikes. The needles tend to be somewhat stiff and sharp, making handling and decorating irritating at times. Because of the long needles and the few branches, hanging of ornaments and tinsel is not facilitated. Actually, the trees require only simple application of commercial "snow" or flocking to achieve a pleasing appearance.

The cold Christmas season in 1958 brought out a serious weakness of the tree. At low temperatures, the needle bases became brittle and were easily broken. Any handling, unless very carefully done, resulted in loss of needles which degraded the appearance greatly. As soon as the tree warmed up in a room, the brittleness disappeared and the remaining needles held tight. Where the leaves had broken off, resin exuded, often in sufficient quantity to drip on the floor. At cold temperatures, the tree tended to have a waxy appearance, and the needles assumed a curved attitude that detracted from its saleability. The temperature at which these undesirable effects took place was not determined, but 1958 was the first year in the several years of harvesting that this condition was noted.

Ponderosa pine normally develops a wide base. Usually the width at the base runs 70 to 90% of the height of the tree. The branches are stiff and generally lack pliability. As a consequence it does not lend itself to bundling for shipping purposes. In use as a Christmas tree it occupies more space than a conventional Douglas-fir or spruce.

Some of the pine trees were mar-



Candle and new side branches of Ponderosa pine prior to pruning.

Candle and new side branches after pruning.

Ponderosa pine before pruning.

Ponderosa pine after pruning.

keted through a local Service Club in 1958. Those that were displayed on stands and decorated with "snow" sold easily in spite of a somewhat higher price tag. Those that were not thus displayed or decorated moved very slowly.

Ponderosa pine does have some potential as a plantation-grown Christmas tree. Its erratic response to pruning, the breakage of needle-bases at low temperatures, shipping difficulties, and poor suitability to traditional decoration are its main faults. These are not insurmountable to a grower who recognizes them and governs his operation accordingly.

To avoid excessive handling, a plantation located close to population centers offers the chance of selling the trees on the stump. The customer can pick his tree and have it cut at the time of purchase. The tree is fresh, only one handling is necessary, and no cut trees will be wasted for lack of selling.

If the trees are to be sold at a local market place, proper display, including the use of flocking material on the tree is highly recommended. Whatever the marketing procedure, the tree that is produced must have good density on all four faces, with acceptable taper, if it is to compete successfully with imported trees. Since most of the imported trees are cut from wild forest lands, it is not too difficult to meet this requirement.

A PROGRESS REPORT

tenderizing meat by chemical injection

By R. L. Saffle and L. D. Kamstra

TENDERNESS IS ONE of the most important aspects of meat quality. Any method by which otherwise juicy and flavorful meat could be made more tender would indeed be of great value to the livestock industry.

We have found that meat may be noticeably tenderized by a chemical injection immediately after animal slaughter. One such chemical is sodium hexametaphosphate (commonly called Calgon), more widely known as a household water softner. When used to tenderize meat however, the reactions are considerably more complex, but in both cases the chelating (binding) properties of the chemical are involved. Recent research has shown that variation in tenderness for any specific muscle is not due to connective tissue as once believed. Muscle protein on the other hand, may affect tenderness to a much greater degree.

Changes in muscle protein were given major emphasis in the present study. The initial work was particularly concerned with the physical and chemical changes of muscle protein as affected by concentration of calcium and phosphorus ions.

Infuse Chemical

Although tenderness is not as variable in pork as in beef, paired hams were used in this study for the sake of economy during this early work. Twenty hogs ranging in live weight from 200 to 225 pounds were slaughtered by conventional methods. Within 15 minutes after sticking, the slaughter process was completed and both hams were removed. One ham from each carcass was infused through the femoral artery with 23.-3% aqueous solution of hexametaphosphate to an increase of 5% of the original weight of the ham. The ham from the opposite side of the same carcass was infused with water only to serve as a control.

To determine tenderness we selected eight persons for a taste panel. Each was given two 1-inch squares of cooked meat, representing samples from the treated and untreated hams of the same animal. This group was not informed as to the identity of the meat samples but was instructed to rate tenderness between samples.

Panel Rates Tenderness

A decided advantage in tenderness was shown for the chemically treated over the non-treated hams. The average of the eight members of the taste panel indicated a higher tenderness score for treated hams over untreated hams in each of the 20 panels conducted. The average tenderness score was 7.29 for the treated hams as compared to 5.35 for the control (Scale: 9—extremely tender; 1—extremely tough).

You could easily distinguish tenderness difference of such magnitude and your family would be more pleased with the resulting cooked product.

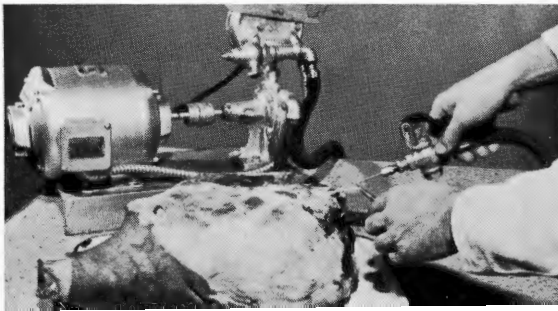
An objectionable dark color of lean occurred in the treated hams. This dark color problem should be corrected by addition of lactic acid to the infusion mixture. The lactic acid caused an increase in acidity which in turn resulted in a return of the normal color to the treated hams.

Before this method of tenderization can be recommended for general usage the following factors must be carefully considered:

1. Complex muscle reaction involved.
2. Approval of the chemical as a food additive.
3. More effective and cheaper chemicals as a substitute for the one used in this study.
4. Determine the most practical infusion method possible.

Once these problems have been removed, the use of chemical injection, especially in improving tenderness of lower grading beef to be more acceptable, would appear possible and profitable. (Project 333, Animal Husbandry Dept.)

Injecting chemical in ham.



● BUFFALO

ANTELOPE RANGE FIELD STATION

Saturday, October 29
Field Day and
Bull Sale

CENTR

Wedne
Small
shelter

PRESH

SOUTH

Friday, S
Row crop

1960 FIELD

EUREKA ●

NORTH CENTRAL SUBSTATION

Friday, July 8
Small grains,
horticulture, cattle
and swine, poultry

NORTHEAST RESEARCH FARM

Thursday, July 7
Small grains

WATERTOWN ●

Tuesday, August 30, Leafy Spurge **LEAFY SPURGE CONTROL FARM** GARY ●

HIGHMORE ●

AL SUBSTATION

sday, July 6
grains,
belt, poultry

SOUTH DAKOTA STATE COLLEGE
BROOKINGS ●

AGRONOMY FIELD DAY, Thur., June 30
DAIRY RESEARCH DAY, Tues., Aug. 2
SWINE EVALUATION STATION BOARD SALE, Fri., Sept. 2
AGRICULTURAL ENGINEERING FIELD DAY, Tues., Sept. 27
SWINE RESEARCH DAY, Thur., Nov. 3

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CENTRAL RESEARCH FARM

September 16
ps

SOUTHEAST RESEARCH FARM

Thursday, September 15, Row Crops

● MENNO

DAYS

mulch protection for vegetables

By Richard Nickeson

USING SOIL MULCHES to boost crop yields is an old, old practice. Some gardeners swear by it; some admit that it is a good practice but requires too much effort; and some claim that it doesn't do much good. To help find out who is right, we started some experiments with mulching materials – particularly black polyethylene plastic—on vegetable plots in 1957.

A mulch is any material put on top of the soil to help a crop. The goal is higher yields, and there are many ways a mulch helps raise yields.

Conserves Moisture, Controls Weeds

Probably the two greatest effects of a good mulch in our state are soil moisture conservation and weed control.

Reducing soil moisture loss is extremely important, for at least two reasons. First, our rainfall is limited to begin with. Second, our sunny weather, high temperatures, constant wind, and low humidity cause rapid evaporation of what soil moisture there is available.

Weed control is also important, as you already know if your garden has ever been taken over by weeds. They literally rob plants of moisture, nutrients, and even sunlight.

Mulches also help reduce soil erosion, soil compaction, and plant disease; influence soil temperature and plant food availability; and improve soil structure and plant quality.

Mulches can be divided into natural or organic and processed or synthetic. Organic mulches include sawdust, leaves, hay or straw, grain hulls, grass clippings, ground corn cobs, compost, and decomposed manure. Paper and polyethylene plastic are examples of synthetic mulches. While each type has its advantages and disadvantages, the goal of each is to increase yields.

Black Plastic Popular

Black polyethylene plastic (black plastic) has received much attention recently. It is cheap, water proof, lasts several years, can be

laid by machine, and can be reused. Early studies indicated that earlier and larger yields, plus savings in weed control more than paid for the plastic and its application.

Black plastic comes in 2- to 4-foot widths and is usually 1½ mils (0.015 inch) thick. You lay it over the soil and plant seeds or transplants in the center through slits. Edges must be covered with soil to keep the plastic from blowing away.

We started tests here to see if black plastic would work in South Dakota. There is an excellent potential for producing high value vegetable crops in our state as irrigation increases. Any cheap way to help conserve moisture will be valuable.

Mulch Seven Crops

We used 2- and 4-foot wide perforated strips of black plastic to mulch five crops in 1957. Crops were Marketer cucumbers, King of the North peppers, Sioux tomatoes, Badger Market cabbage, and Green Mountain broccoli. North Star Hybrid sweet corn and Tendersweet carrots were mulched with 2-foot wide plastic. The first five crops were transplants, and the corn and carrots were seeded.

Carrot seeds were planted first. We covered the row with two strips of plastic taped together with one-half inch between for the plants to grow through. Cabbage and broccoli were planted in late April and the other crops were planted in late May. We didn't irrigate. Rows were 25 feet long and repeated twice, with two rows not mulched to check results.

Cabbage, cucumbers, peppers, and carrots mulched with black plastic yielded at least 10% more than the check (see figure 1). The huge increase in carrots was due partly to a thick stand. More carrots germinated and survived in the black plastic mulched plots. Cucumbers and cabbage matured earlier when mulched with plastic.

Width of plastic didn't seem to make much difference. You should get the same results, with less cost, by using the narrower sheets.

Compare Plastic With Organic Mulches

In 1958 we compared 2-foot sheets of black plastic, 2-foot sheets of white plastic, sawdust, chopped silage (to simulate grass clippings) and ground corn cobs. Crops were F-M Cross sweet corn, Pearl-green snap beans, Nantes carrots, Badger Market cabbage, Ashley cucumbers, and Siouxann Hybrid tomatoes. Rows were 10 feet long and each crop was repeated twice. We included white polyethylene plastic because we thought its reflective

FIG. 1 *Yields of seven vegetable crops mulched with two widths of black plastic – expressed as per cent of the non-mulched check – 1957*

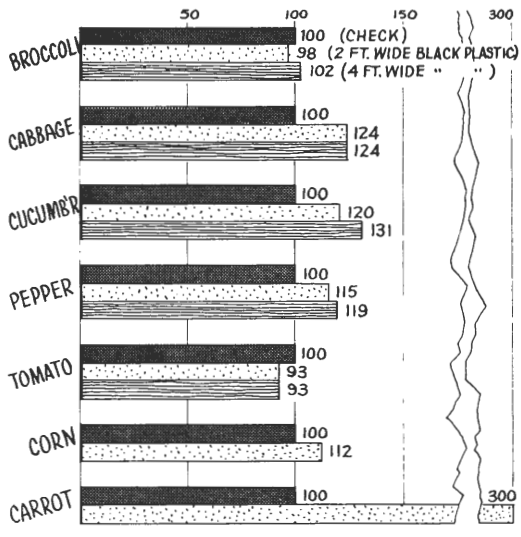
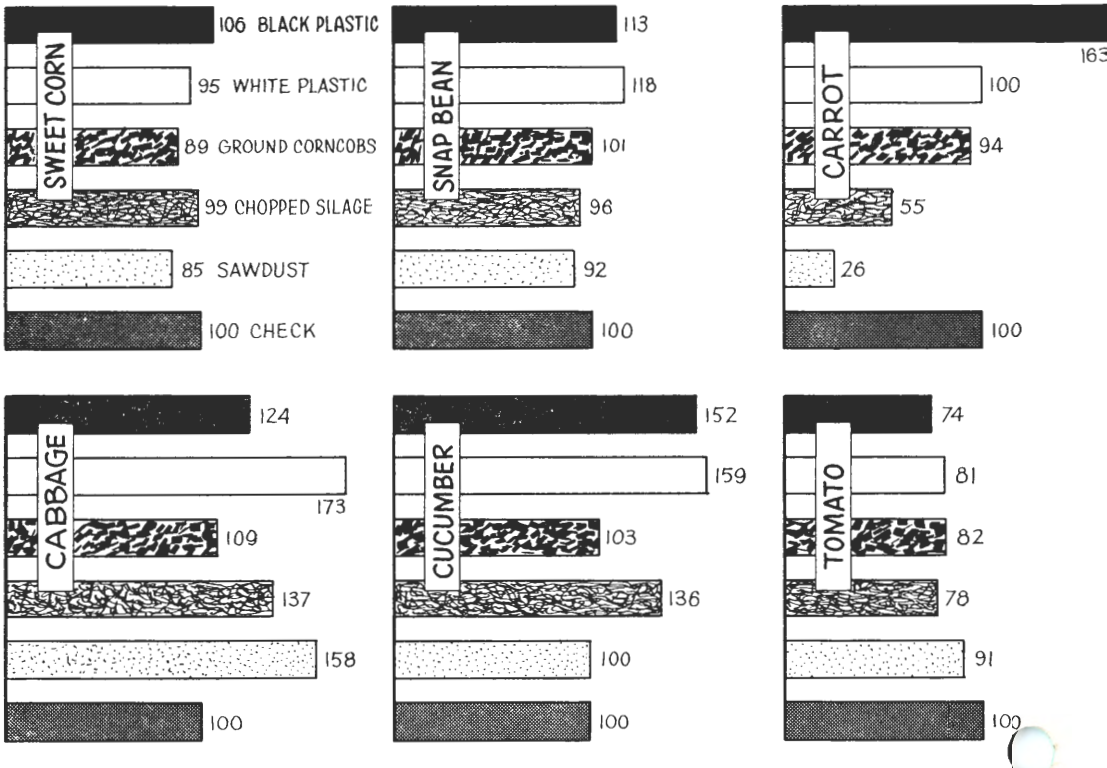


FIG. 2 *Yields of six vegetable crops with five mulch treatments – expressed as per cent of the non-mulched check – 1958*



properties might lower soil temperature. Neither plastic was perforated.

About 3 weeks after planting, we sidedressed ammonium nitrate in all plots. We dissolved the fertilizer in water and applied at the base of each plant in the plastic-mulched plots. At this time, the three natural mulches were fertilized, 1½ to 2 inches deep. Plots were irrigated with about 1½ inches of water three times.

Because of late planting, it wasn't surprising to find that only corn, cucumbers, and snap beans were earlier in the plastic-mulched plots. Yields are shown in figure 2. Again, the carrot yields reflect stand and will not be discussed. (It is interesting, however, to note that both years the stand of carrots in plastic-mulched plots was definitely superior.) Cabbage yields were higher under white plastic than black plas-

Table 1. Average Morning and Afternoon Soil Temperatures Under Five Mulches and in Non-Mulched Soil, 1958

	Black plastic	White plastic	Ground corncobs	Chopped silage	Sawdust	Check
Morning	76°F.	75°F.	70°F.	71°F.	69°F.	73°F.
Afternoon	89°F.	84°F.	76°F.	75°F.	73°F.	86°F.

tic, but yields for other crops were similar under both types.

You can see that black plastic increased yields of every crop except tomatoes, the same as in 1957. We're not sure why this happened since other warm season crops apparently benefited from the plastic. Tomato plants were pruned and staked. Blossom end rot was not more prevalent in plastic-mulched rows.

Average temperatures in plots, at 8 to 9 a.m. and 4 to 5 p.m., are shown in table 1. The higher temperatures in plastic-mulched plots likely helps increase earliness in some crops. Natural mulches kept soil cooler but did not seem to give better yields than unmulched plots in most cases.

Yields of white plastic-mulched plots were highest in all but one case. However, this material costs more than black plastic, and more important, it does not control weeds. Results again indicate that black plastic increases yields of most vegetable crops.

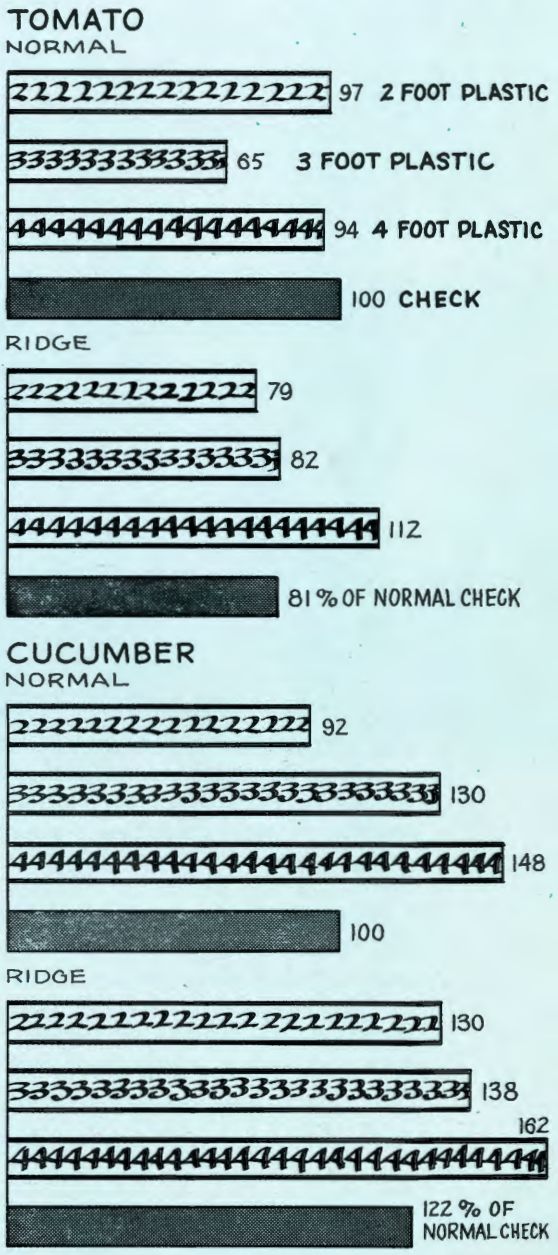
Because of poor results with tomatoes, though, we decided to continue tests one more year.

Test Two Cultural Methods

We used two cultural methods in our 1959 tests with tomatoes. Normal planting on level soil was compared with ridge planting, where the crop was planted on a ridge of soil several inches above the general level of the field. The ridges were 4 to 6 inches high and about 1 foot wide at the base .

Black plastic was tested in 2-, 3-, and 4-foot widths on both level and ridge plots. We felt that wider plastic might raise tomato yields. Fordhook Hybrid cucumbers and State Fair Hybrid tomatoes were planted.

FIG.3 Yields of tomatoes and cucumbers mulched with three widths of black plastic and grown under two cultural methods – expressed as percent of the non-mulched check – 1959



In the first two years, cucumbers had responded poorly. Rows were 15 feet long. Each of the eight treatments was repeated four times. Before planting, we broadcast and disked in 50 pounds of nitrogen per acre. Rainfall was supplemented with 2.15 inches after planting and 2.35 inches in August. Planting was delayed until June because the black plastic arrived late.

Soil moisture variation during July and August was checked but results were inconclusive. We noted, however, that after a heavy rain or irrigation, the 3-foot plastic strips did not prevent water from reaching 18 inches into the soil.

Only one tomato harvest and two cucumber harvests were possible. The late planting was followed by frost 3 weeks earlier than normal. Because of the limited results, we did not analyse data statistically.

You can see that growing cucumbers on ridges produced higher yields for every treatment (see figure 3). There was also a definite increase in yield as width of plastic was increased.

Again, though, tomatoes did not benefit in yield from black plastic mulch. Normal planting usually gave better yields than ridge planting.

Black plastic apparently increased soil temperatures, at least to a 12-inch depth (see table 2). Notice that soil temperature decreased with depth. At all depths, soil temperature was higher in plastic-covered plots. The soil warming effect of plastic is most noticeable during the early part of the season and on sunny days. After plants begin to cover the ground, and on cloudy days, there was little difference in soil temperature. It seems that an early crop would probably benefit from black plastic mulch and possibly also from ridge planting.

Of four herbicides, only Simazin controlled weeds effectively. In the Simazin-treated strips, we did not have to cultivate during the entire season.

Summary

Black polyethylene plastic as a soil mulch for vegetable crops:

1. Increases the yield of most vegetables, except tomatoes.
2. Gives results as good as, or better than, common organic mulches on most crops.
3. Eliminates a large amount of time and work with weed control.
4. Promotes earliness in many crops.

Black plastic costs about 7 cents per square yard. You could reduce the cost by reusing the plastic. The cost is further equalized when you consider that you will spend less time and work on weed control, probably get higher and earlier yields, better quality, and more attractive fruit. As thinner, cheaper plastic film and better cultural methods are developed, the use of black plastic in vegetable growing will no doubt increase even more. (Project 118, Horticulture Dept.)

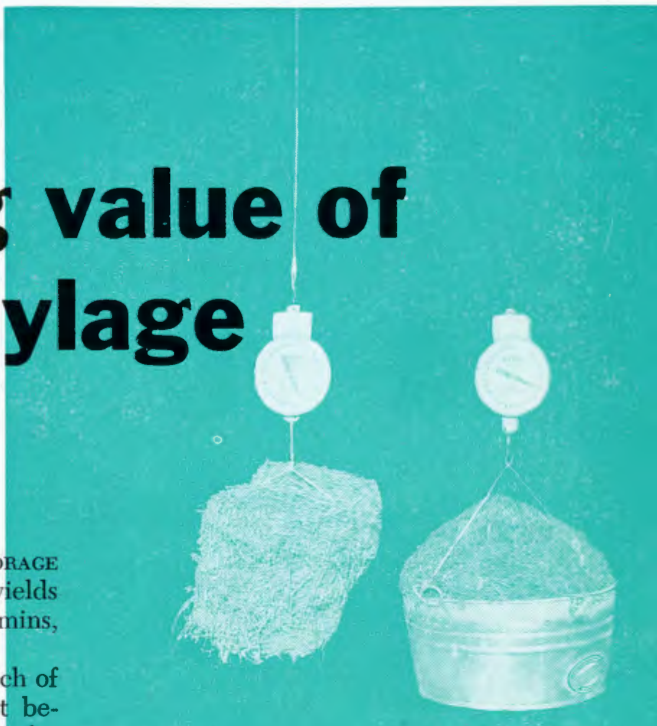
Table 2. Average Afternoon Soil Temperatures at Three Depths Under Black Plastic Mulch and No Mulch for Two Cultural Methods, 1959

	Normal		Ridge		
Depth	3 ft. black plastic	Check	3 ft. black plastic	Check	Air
3 inches	79°F.	77.5°F.	89°F.	81°F.	88°F.
6 inches	76°F.	73.5°F.	79°F.	76°F.	
12 inches	74.5°F.	71.5°F.	74°F.	72.5°F.	

feeding value of alfalfa haylage

FOR DAIRY CATTLE

By H. H. Voelker



The 39.5 pounds of alfalfa haylage (right) is equal in dry matter to 13 pounds of excellent alfalfa hay.

ALFALFA IS AN EXCELLENT FORAGE for milk production. It yields a lot of protein, minerals, vitamins, and net energy.

Unfortunately, however, much of the good feeding value is lost because of rain on alfalfa made for hay, and leaves lost in harvesting. Alfalfa is often preserved as silage, but with great difficulty, because high nurient losses, strong odor, and poor palatability may result.

A great deal of research has pointed out the importance of low moisture and exclusion of air in efficient preservation of alfalfa silage. The alfalfa can be dried to less than 50% moisture, sometimes as low as 20% moisture, and sealed in air-tight structures. Such material is called "haylage."

Alfalfa Haylage for Milk Production

The value of alfalfa haylage was tested with dairy cows in a conventional feeding trial. We wanted to compare the haylage with the best known method of hay making, using third cutting alfalfa which had been irrigated. The alfalfa was in the bud stage of maturity and was very fine-stemmed and leafy, approximately 17 inches tall when cut. Using different windrows in the same field, half of the alfalfa was dried to 40% moisture, chopped as finely as possible, weighed, and blown into an air-tight silo. The other half was flail-chopped to as long lengths as possible, weighed, and finished drying on an outside cold air fan drier. There appeared to be considerable leaf loss in loading the long-cut alfalfa. There also was some leaf loss in subsequent baling and some ad-

ditional breaking of stems upon handling. After drying, the hay was stored for winter indoors.

The hay stems were left as long as possible because previously chopped and artificially dried hays resulted in sore mouths of cows. Many of the stems were 7 to 8 inches long.

Twenty dairy cows were divided into two comparable groups. There were two Guernseys, four Brown Swiss, and four Holsteins in each group. A preliminary period was used prior to the trial. The cows were weighed for 3 successive days at the start and end of the periods. Two feeding periods were used so that each cow received hay one period and haylage one period. A post-treatment period was then used.

Half of the cows (five in each roughage group) received the regular herd concentrate mixture. The other half received rolled, shelled corn with 1% bone meal and 1% trace mineral salt added. The herd mix was composed of 1,700 pounds rolled corn, 1,600 pounds rolled oats, 200 pounds soybean oil meal, 200 pounds linseed oil meal, 200 pounds wheat bran, 50 pounds trace mineral salt, and 50 pounds steamed bone meal. It contained 13.9% protein by analysis. The object was to determine if this more complex mixture was necessary when the high protein haylage or hay was fed. The concentrates were fed at the rate of 1 pound to 3 pounds of 4% fat-corrected milk produced at the start of each period.

Results of the Milk Production Trial

The results of the milk production trial are summarized in table 1.

The cows on the haylage consumed 3.2 pounds more dry matter daily than they did while they were fed the artificially-dried hay. This reflects the problem of sore mouth with sharp stem-ends in the chopped hay.

As in other feeding trials, there was a tendency for the cows fed alfalfa haylage in body weights, gaining 17 pounds per cow each 28-day period, whereas the cows on hay lost 10 pounds per cow. This was a statistically significant difference.

The milk production responses on haylage and artificially dried hay were very similar. However, the cows previously fed haylage, while in the post-experimental period, even though they were on a very adequate ration, declined more in production than did the cows fed hay. The cows in both groups gained considerably in body weight in the post-treatment period, the post-hay group gaining 10 pounds more body weight per cow than those after going off haylage. Roughage consumption, also was greater for the cows going off the dried hay.

The milk total solids production was determined by lactometer during the preliminary periods and during the experimental periods. The total milk solids produced declined 6.7 pounds per week for the ten cows while they were on haylage compared to a decline of 35.2 pounds total milk solids for the ten cows on hay. After going off haylage the ten cows declined 29 pounds total milk solids, whereas the cows off hay increased 9 pounds total milk solids. Why there appears to be these differences is difficult to

Table 1. Feed Consumption, Body Weight, and Milk Production

Items Compared	Alfalfa haylage	Artificially dried hay
Number of cows	10	10
Daily rations per cow	Pounds	
Concentrates	14.2	14.1
Alfalfa as fed	40.2	21.6
Alfalfa dry matter	23.1	19.9
Live weight of cows:		
Initial weight per cow	1291	1298
Final weight per cow	1308	1288
Gain or loss in weight per cow	+17	—10
Milk production:		
Daily 4% FCM produced per cow	37.7	37.3
Butterfat produced per cow	1.50	1.48
Solids-not-fat per cow	3.36	3.32
Post-treatment (28 days):		
Daily rations per cow:		
Concentrates	17.0	17.0
Molasses-beet pulp	4.0	4.0
Corn-soybean silage	28.2	30.5
Alfalfa hay (dry matter)	11.4	12.0
Gain or loss in weight per cow	+30	+40
Milk production (post-treatment):		
Daily 4% FCM per cow	35.0	37.7
Daily butterfat per cow	1.38	1.52
Daily solids-not-fat per cow	3.22	3.58

explain, and it suggests further research in this area.

Haylage for Heifers

Heifers must be well grown to make good herd replacements. To develop body capacity in heifers, you should feed them large amounts of good roughage. If high yielding legume pastures are used, there is a constant danger of loss of animals from bloat. Also, alfalfa cut and stored at the bud or early bloom stages of maturity will yield much better and maintain a good stand longer than pastured alfalfa.

To test the feeding value of alfalfa preserved as haylage in comparison with green chopping of the alfalfa, we conducted group trials during the summers of 1958 and 1959 using a total of 76 heifers. In 1959, 40 dairy heifers averaging 16.5 months of age and 780 pounds were divided into four groups as closely as possible according to age, breed, and weight. Three Guernseys, six Holsteins, and one Brown Swiss were in each group. The heifers were weighed and measured for 3 successive days at the start and end of the feeding trial and they were weighed once each week at the same hour before feeding.

Again in 1959 the previous trial was repeated, except nine heifers per group were used, and the groups were subdivided into large heifers (957 pounds) getting no grain, and a smaller group (572 pounds) get-

ting 4 pounds concentrate daily per head.

The concentrate mixture was 48% rolled shelled corn, 48% rolled oats, 1% steamed bone meal, and 1% trace mineralized salt. Iodized block salt was also offered free choice. The forages were fed to the limit of appetite twice daily. All the feed was weighed in and feed refusals were weighed back. This refusal was kept to a minimum. At the beginning of 1958, the green-chopped alfalfa was fed once daily. However, heating and poor consumption made it necessary to chop twice daily. Each year, the glasslined silo was filled twice during the trials.

Response of the Heifers

The total roughage and total dry matter consumed and body weight gains are shown in table 2.

The heifers on the haylage consumed more dry matter daily than the heifers fed green-chopped alfalfa.

Haylage Intake Is More Regular

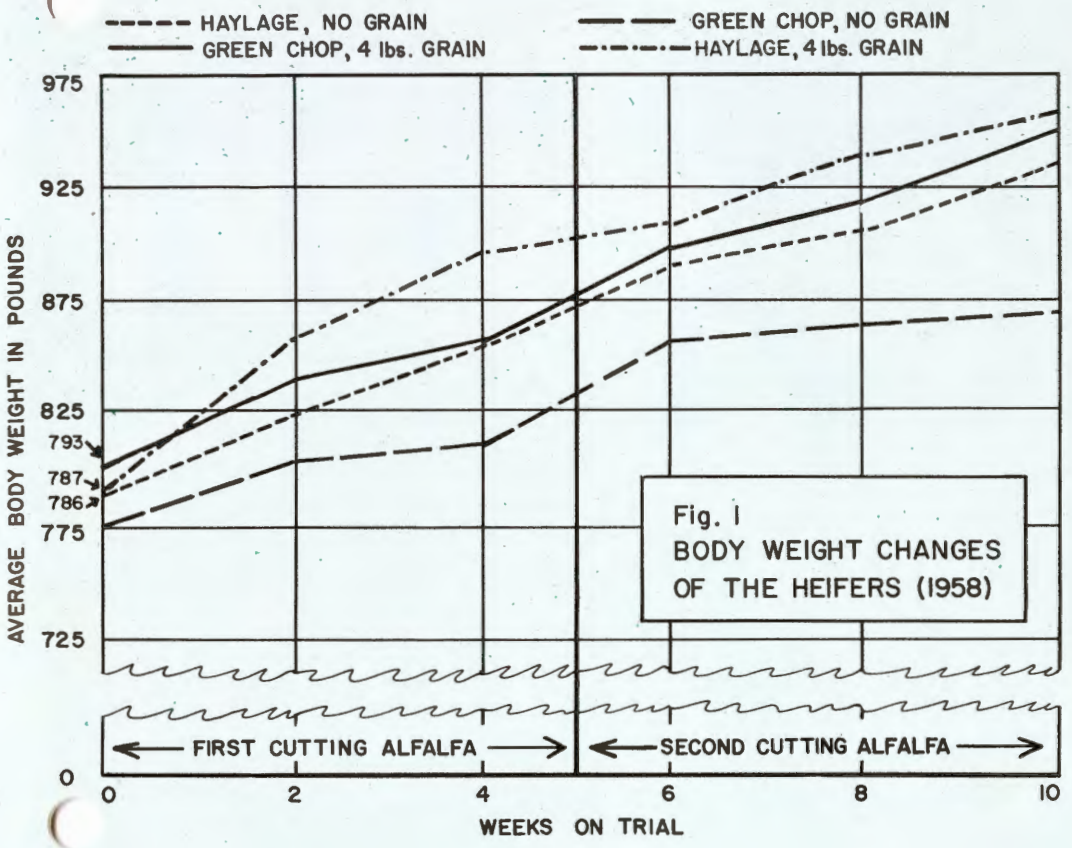
During both years, the consumption of green-chop was more irregular from week to week, varying with the stage of maturity. Also, the weather and rain, or lack of it, influenced the green-chop consumption more than it did the haylage. During 1958, the average weekly deviation (from the average of the entire period) in dry matter consumption was 80 pounds for heifers fed haylage, no grain; haylage, plus grain, 81 pounds; green-chop plus grain, 96 pounds; green-chop, no grain, 116 pounds. The grain appeared to have a more stabilizing effect on consumption of green alfalfa than on haylage. Rainfall was about half normal and the green-chop matured quickly, especially in late summer.

During 1959, again, the heifers fed haylage fluctuated little from week to week in dry matter consumption. Also the grain tended to stabilize the dry matter consumption. The average weekly deviations in dry matter were as follows: haylage, no grain, 38 pounds; haylage, plus grain, 29 pounds; green-chop, no grain, 92 pounds; green-chop plus grain, 48 pounds. Perhaps this could account for part of the differences in growth rates.

Growth of Heifers

The changes in body weights are plotted in figures 1, 2, and 3. In both years the heifers on haylage gained more in body weights than did the heifers fed the green-chopped alfalfa. The differences were statistically significant the first year, and they approached significance the second year. It is especially apparent that the gains in weight were slowed down on either haylage or green-chop when more mature alfalfa was used.

Body measurements were taken at the beginning and end of the trials each year. In 1959 body measurements were taken for 3 successive days at the start and finish. The measurements included height at the wither tops and body lengths. In general, these differences were small. In 1959 the group fed haylage plus grain increased 34 centimeters total height at withers; green-chop with grain, 28 centimeters; haylage alone, 20 centimeters; and green-chop alone, 18 centimeters.


HAYLAGE, NO GRAIN
GREEN CHOP, 4 lbs. GRAIN
GREEN CHOP, NO GRAIN
HAYLAGE, 4 lbs. GRAIN
AVERAGE BODY WEIGHT IN POUNDS
975
925
875
825
793
787
786
775
725
0
FIRST CUTTING ALFALFA
SECOND CUTTING ALFALFA
0
2
4
6
8
10
WEEKS ON TRIAL
Fig. 1
BODY WEIGHT CHANGES
OF THE HEIFERS (1958)

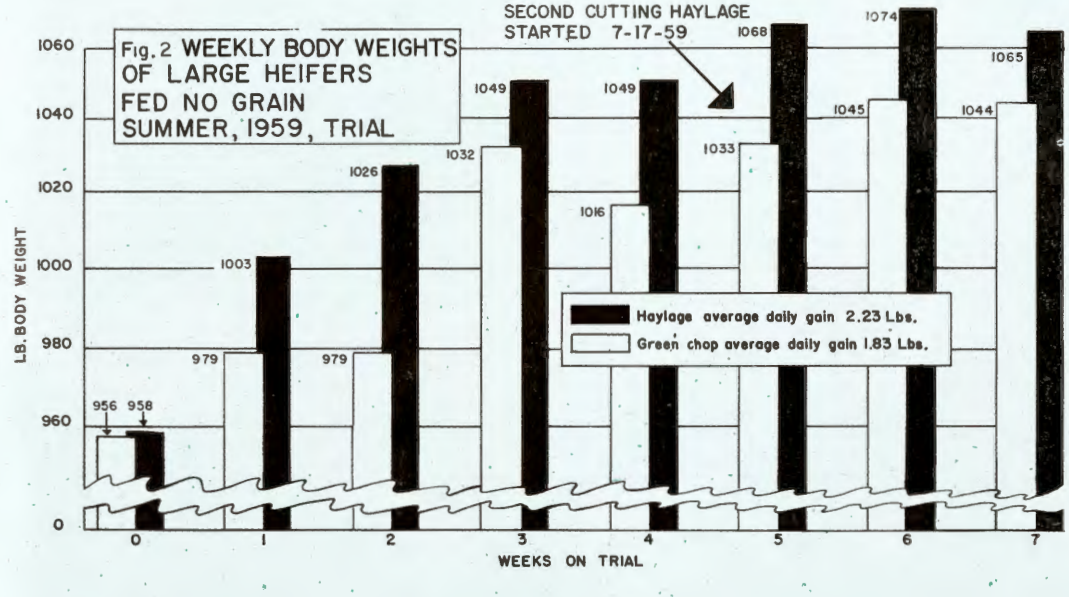
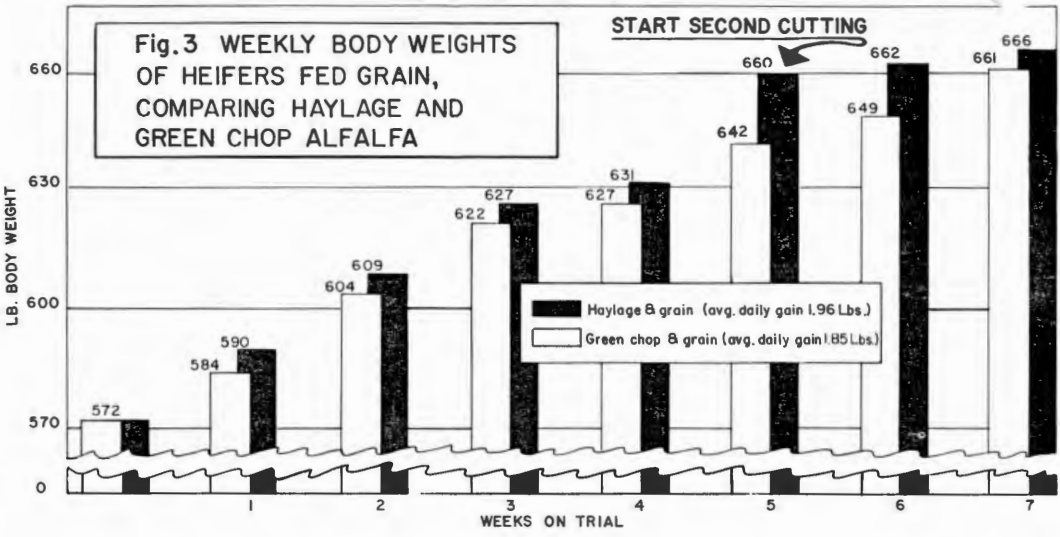


Fig. 2 WEEKLY BODY WEIGHTS
OF LARGE HEIFERS
FED NO GRAIN
SUMMER, 1959, TRIAL
SECOND CUTTING HAYLAGE
STARTED 7-17-59
LB. BODY WEIGHT
1060
1040
1020
1000
980
960
0
956
958
979
1003
979
1026
1032
1049
1016
1049
1033
1068
1045
1074
1044
1065
Haylage average daily gain 2.23 Lbs.
Green chop average daily gain 1.83 Lbs.
0
1
2
3
4
5
6
7
WEEKS ON TRIAL



The differences in gains (see table 2) in body weight between the haylage and green-chopped alfalfa can be explained in part, at least, on differences in dry matter consumption. Especially during hot weather, the green-chopped alfalfa, even though fed twice daily, heated some before it was all consumed. Also, the haylage was cut at more nearly the optimum stage of maturity, whereas more of the fresh-fed alfalfa reached full bloom maturity. In the haylage, also, however the full-bloom cut haylage resulted in no or very small gains. In 1959 the large heifers had been on low quality hay and silage before the haylage trial started. The small heifers received grain and good quality hay before the trial started.

The sealed jar illustrates the principle of sealed storage. Haylage stored unsealed continues oxidation—just as the candle continues to burn in the unsealed jar.

No Bloat in Haylage Group

Bloat was a problem only in 1958. There was no bloat in the haylage groups. The most severe bloating occurred in the heifers fed green-chopped alfalfa, with no grain. In this group one Guernsey heifer died on July 10, 1958. A substitute heifer was used in her place thereafter. Several others had severe bloat. A total of five less severe cases occur-

red in four heifers. Eight other light cases of bloat were present in this group. Only two slight cases of bloat were observed in the group fed the same green-chop with grain. After the first heifer died, the heifers were supplemented with steamed bone meal as a source of phosphorus. This did not appear to reduce the bloat problem. The gains in body weight were reduced after the bloating occurred.

Chemical Determinations

The feed samples were taken every third load in filling the air-tight silo and usually once each week during feeding. From table 3 it can be seen that in this area, the fine, leafy early-cut alfalfa is relatively low in crude fiber, and is an excellent source of protein. In estimating a balance of feeding standard needs, the alfalfa furnished nearly twice the amount of protein that should be needed for milk production. Especially in trial 1, the analyses were similar to high quality dehydrated alfalfa meal. We plan further trials to determine feeding level of concentrates, supplements, etc. in relation to the use of haylage.

In summary, you can use alfalfa—either green-chop or haylage—to good advantage for milking cows or growing heifers. However, the cost of sealed storage units may be a limiting factor in their use on many farms.

Table 2. Roughage Consumption and Weight Gains of the Heifers

Ration	Pounds	
	Dry matter per heifer daily	Average daily gain
1958		
Haylage, no grain	21.7	1.92
Haylage, 4 lbs. grain	23.5	2.43
Green-chop, no grain	17.9	1.49
Green-chop, 4 lbs. grain	20.3	1.92
1959		
Haylage, no grain (large heifers)	24.4	2.23
Haylage, 4 lbs. grain (small heifers)	19.2	1.96
Green-chop, no grain (large heifers)	19.7	1.83
Green-chop, 4 lbs. grain (small heifers)	16.1	1.85

Table 3. Chemical Determinations

Trial roughage	Moisture (%)	Dry basis					
		Ether extract (%)	Crude fiber (%)	Crude protein (%)	Ash (%)	NFE (%)	Carotene (Mcg. 1 g)
1 Haylage (cows)	40.3	2.54	23.66	22.63	8.36	42.81	68
1 Artificially dried hay (cows)	8.0	2.29	27.96	20.03	7.46	42.26	72
2 Haylage (heifers)	51.5	4.24	21.95	21.26	9.88	42.67	115
2 Green-chop (heifers)	71.0	4.02	19.76	23.43	10.28	42.51	246
3 Haylage (heifers)	44.4	2.83	27.53	17.45	9.84	42.35	84
3 Green-chop (heifers)	74.0	2.65	29.73	15.11	9.38	43.13	248

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To _____

J. W. McCarty
Animal Husbandry