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fertilization and spacing of irrigated corn

on the Belle Fourche Irrigation Project



Unfertilized field, left, adjoining plot fertilized with 120 pounds of available nitrogen

AGRONOMY DEPARTMENT
AGRICULTURAL EXPERIMENT STATION
South Dakota State College, Brookings, in cooperation with
SOIL AND WATER CONSERVATION RESEARCH BRANCH, ARS
United States Department of Agriculture

fertilization and spacing of irrigated corn

on the Belle Fourche Irrigation Project

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Corn is one of the major crops grown for livestock feed in western South Dakota. This crop is grown both on irrigated and nonirrigated land. It is used as silage, harvested for grain, and fed as fodder.

Because of its importance, corn was one of the crops that received special attention when an off-station research program was started on the Belle Fourche Irrigation Project by the Newell Field Station in 1950.

Objectives under consideration were to study the value of nitrogen and phosphorus fertilizer and the effect of plant population on the production of silage and grain corn. The trials conducted and their locations are shown in table 1.

Results obtained in the field trials conducted on irrigated land from 1950 through 1954 are discussed in this publication. The principles of proper corn culture are of economic value to farmers on the Belle

Fourche Irrigation Project and to neighboring irrigated areas.

Conducting the Trials

The trials were conducted in cooperation with farmers of the area. The cooperating farmer performed all operations essential to the production of the crop except planting, fertilizing, and harvesting. These operations were performed by personnel from the Newell Field Station.

The treatments, consisting of various rates of nitrogen and phosphorus fertilizers and various plant populations, were placed on plots 4 corn rows wide and 50 feet long. Fertilizer was applied as a band beside the row soon after the corn emerged.

The plant population desired was obtained by planting the corn thick and then thinning after emergence. The two middle rows of each 4-row

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plot were harvested for the determination of yield. The treatments were repeated three to five times at each location. Thus the results and discussion are based on treatments repeated many times in corn fields.

Each of the trials will not be discussed in detail in this publication. The principles involved are considered of greatest importance, and a summary of some of the results is given in the figures. Examples will be used from these data to help explain some of the principles.

Nitrogen Fertilizer

When a corn plant is not obtaining sufficient nitrogen, it develops a characteristic yellow color. The yellow color first appears on the leaf tips of the older leaves and follows the midrib inward toward the plant stalk. As the deficiency becomes more severe the leaves higher on the plant and more of the leaf area turn light green or yellow.

This develops at any stage of growth, but it is usually most appar-

ent soon after silking. The yellow area of the leaf turns brown and dies if the deficiency is severe. It is not difficult to distinguish between the leaves that die because of nitrogen deficiency and those that die from drought. When drought occurs the leaves curl and dry but usually retain their green color for a brief time.

The healthiest plants are those that remain green until damaged by frost. There is no advantage in letting the plant turn yellow late in the season.

The yellow coloration is a visible symptom, but it is usually accompanied by corresponding effects on the yield and protein content of the corn. In the trials conducted, the yield and protein content of the grain were increased by the application of nitrogen fertilizer at approximately two-thirds of all the locations.

On those fields where nitrogen was needed, 50 to 60 pounds of applied nitrogen per acre was usually sufficient, and only occasionally

Table 1. The Location and Type of Trials Conducted on the Belle Fourche Irrigation Project

NO.	YEAR	COOPERATOR	LOCATION	SOIL TYPE	TYPE OF TRIAL
1	1950	E. Gutsche	Nisland	Vale sandy loam	Fert. x plant pop.*
2	1950	Exp. Station	Newell	Pierre clay	Fert. x plant pop.
3	1951	F. Kiel	Nisland	Clay loam	Fertility
4	1951	G. Cox	Vale	Vale sandy loam	Fertility
5	1951	A. Schecler	Vale	Vale sandy loam	Fertility
6	1952	L. C. Williamson	Vale	Vale sandy loam	Fert. x plant pop.
7	1952	J. Bentz	Nisland	Clay loam	Fert. x plant pop.
8	1953	G. Kimball	Horsecreek	Pierre clay loam	Fert. x plant pop.
9	1954	G. Herman	Nisland	Sandy loam	Fert. x plant pop.
10	1954	D. Tucker	Nisland	Vale sandy loam	Fert. x plant pop.
11	1954	K. Anderson	Newell	Pierre clay loam	Plant population

*Combination trial on fertility level and plant population.

was it profitable to apply as much as 100 pounds per acre. The term "pounds of nitrogen per acre" refers to pounds of nitrogen and not to pounds of fertilizer. Nitrogen content of commercial fertilizer used in the area will vary from 20 percent for ammonium sulfate to 82 percent for anhydrous ammonia.

The magnitude of response to nitrogen as well as the average yield for all treatments varied considerably between the trials at the various locations. The wide variation is apparent if the lines representing the yields in figure 1 are compared.

The variable plant response to fertilizer nitrogen may be attributed to differences in soil texture, as modified by slope. Trials that were located on the heavier clay soils, trials 2, 3, and 8, were low yielding in comparison to trials on the sandier soils.

Trial 6 (figure 1) represents a typical situation where a response to nitrogen was obtained. The yields of corn receiving 0, 60, and 120 pounds of nitrogen per acre were 54, 67, and 69 bushels per acre, respectively. Note that the response was much larger for the first 60 pounds of nitrogen than for the second 60 pounds applied.

In the same trial, the protein in the grain was 6.5, 7.8, and 8.6 percent, respectively, for the 0-, 60-, and 120-pound rates of nitrogen.

When the leaves of corn turn prematurely yellow, there is usually a deficiency of nitrogen in the soil. To correct the deficiency immediately, apply more nitrogen fertilizer or, on a long-term basis, plow under more green manure in the rotation.

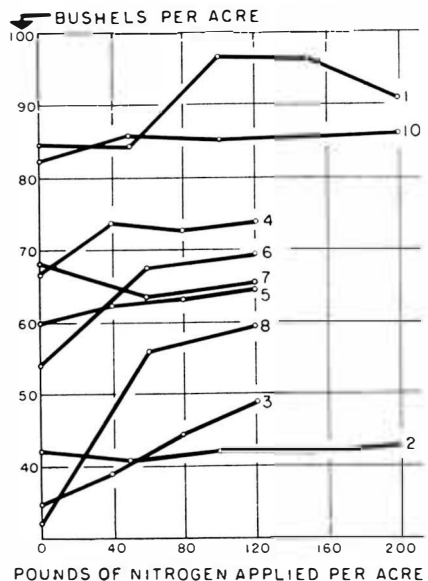
Nitrogen not used by one crop will in part be available for the next.

It is possible to leach out the nitrogen on the sandier soils if excessive water is applied. But residual effects of nitrogen often have been observed one and two years after application on these soils. Evidently the leaching away of nitrogen is not a serious problem, and residual nitrogen will remain in the soil for the next crop that is grown.

Phosphorus Fertilizer

The phosphorus requirements and response of the corn plant was not as marked as with nitrogen. Applications of phosphorus increased the yields in about one-third of the

Figure 1. Effect of nitrogen on the yield of corn (average of all plant populations). Figures at ends of lines refer to trial numbers listed in table 1.



trials. Yield increases from 3 to 10 bushels were obtained through the use of phosphorus.

Corn does not require as much phosphorus and does not respond to applications of phosphorus to the extent that it does to nitrogen. It is apparent that there were some increases in yield as a result of applications of phosphate in about one-third of the trials. Where there was an increase in yield attributed to applications of phosphate, the increase was usually much smaller than the increase due to nitrogen.

It seems advisable to maintain a good phosphorus level in the soil by placing the phosphate fertilizer on other crops in the rotation, such as alfalfa and sugar beets, rather than to make applications to the corn crop. Nitrogen is by far the most important fertilizer element that needs to be supplied when producing corn.

Plant Population

In all the trials, the yield of grain produced was consistently increased as the plant population was increased to a limit of approximately 20,000 plants per acre. Note that there is a uniform upward slope to the lines in figure 2. There is also a tendency for them to level to a horizontal position at 20,000 to 22,000 plants per acre. It has already been pointed out that the response to nitrogen was quite variable; but in contrast there is consistently an increase in the yield with increased plant population to 20,000 plants per acre.

As the plant population is increased above 12,000 or 14,000

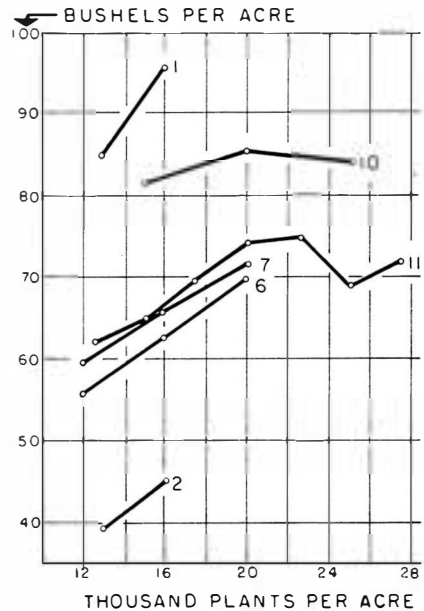


Figure 2. Effect of plant population on the yield of corn (average of all fertility levels). Figures at end of lines refer to trial numbers listed in table 1.

plants per acre, the size of the ear usually decreases. Too often the practice of using high plant populations is condemned because of the smaller ears. It must be realized that the increase in the number of ears will more than make up for the decrease in size.

There is no apparent reason why fewer than 14,000 plants per acre (a foot apart in 38-inch rows) should ever be planted on irrigated land. If the fertility level of the soil and cultural practices are good, a plant population of 20,000 plants per acre would be preferred. For the production of silage 20,000 plants or more per acre are not too many (see figure 3).

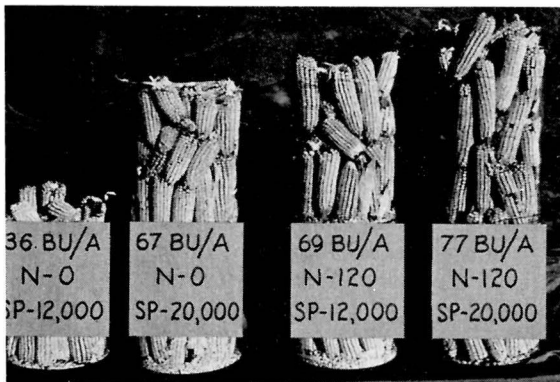
How much seed must be planted to give the desired plant population? There are approximately 1,600 kernels of corn per pound of medium flat seed. To obtain 18,000 seeds per acre it will be necessary to plant 11 to 12 pounds of seed. If a row width of 38 inches is being used, set the planter so a seed is dropped about every 9 inches. This will be 18,330 seeds per acre.

For narrower rows the seeds are farther apart, and for wider rows they are closer together. Allowance must also be made for poor germination, poor soil conditions, and for seed eaten by pheasants and rodents.

Relationship of Plant Population to Fertilizer

The discussion so far has been concerned with spacing or fertilizer as independent factors. Although it is more complicated to consider the

Yields of corn at populations of 12,000 and 20,000 plants to the acre. No fertilizer was added to the plots represented by the two wire baskets on the left; 120 pounds of available nitrogen to the acre was supplied to those on the right.



two factors together, it is necessary to consider their effects on each other if the best use is to be made of the principles involved.

As the number of plants growing on an acre of land increases, it is obvious that the amount of nitrogen those plants will need to grow properly will increase. There is also a limit to the number of plants that can be grown on an acre even though there is ample nitrogen in the soil.

Applying adequate amounts of commercial fertilizer will, to a certain extent, compensate for a poor stand of corn. Likewise, a proper stand will at times partially compensate for the lack of fertility as far as yield is concerned. These principles can be demonstrated by using the results of one of the trials.

In trial 8 in 1953 and trial 9 in 1954, the yield and protein content of both the silage and grain were determined for various plant populations and fertilizer levels. At both locations a definite response was obtained to applications of nitrogen. Trial 9 will be used as an example because more rates of fertilizer were used at this location.

Where no nitrogen fertilizer was applied, the increase in plant population resulted in a decrease in the yield of grain and had little or no effect on the silage yield. Thus the amount of grain corn in a ton of silage was reduced. This would probably reduce the feeding value of the silage. There is nothing to gain and a loss is probable if the plant population is increased above 14,000 plants per acre on a soil very deficient in nitrogen.

By applying 50 pounds of nitrogen per acre, the deficiency was largely corrected. At this level of fertilizer, an increase in the plant population resulted in an increase in the yield of silage but only a slight increase in the yield of grain.

When 100 pounds of nitrogen was applied, the deficiency of this element was corrected. The yield of grain and silage both increased as the plant population increased. There was little or no advantage in applying more than 100 pounds of nitrogen per acre.

The more economical procedure to increase the production of corn is to insure against a deficiency of nitrogen without "excessive" use and then plant ample seed. The

corn crop is not likely to be injured by applying as much as 200 pounds of nitrogen per acre, but it is expensive when 50 to 80 pounds is enough. There is no danger if as much as 14 pounds of seed is planted on each acre.

Use of fertilizer is a good practice, but it can be made a better one if 18,000 or more plants are grown on each acre.

Protein Content

Whenever the yield was increased by the application of nitrogen, the percent protein in the grain was usually increased. The plant population had little effect on the protein content except for a slight tendency, in some trials, for the

Figure 3. Effect of plant population and nitrogen fertilizer on the yield of grain and silage for trial 9 in 1954.

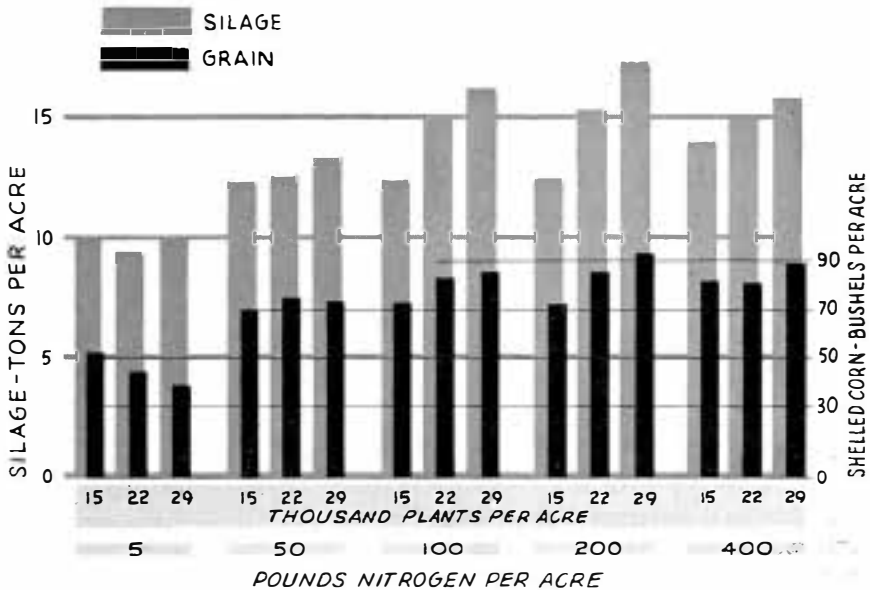


Table 2. Comparative Average Yields of Corn Varieties Grown on Both the Clay and the Sandy Soils of the Belle Fourche Irrigation Project, 1952-54

VARIETY	CLAY SOIL		SANDY SOIL	
	YIELD BU./A.*	% MOISTURE AT HARVEST	YIELD BU./A.*	% MOISTURE AT HARVEST
Funks G-18	71.5	18.6	114.2	26.2
DeKalb 56	69.3	17.9	99.6	23.4
Sokota 220	68.1	16.5	100.8	18.7
Sokota 262	62.8	21.2	100.8	26.8
Wisconsin 355	61.4	18.6	93.3	23.3
Funks G-11	60.1	16.7	93.6	20.8
Jacques 853J	59.6	16.5	91.6	20.3
Kingscrot KE3 ..	58.1	14.2	80.5	14.9

*Bushels per acre at 15.5 percent moisture.

protein content to decrease as the plant population increased. This occurred when the corn was grown on soil very deficient in nitrogen.

Variety

Varietal choice is quite important when producing corn, as there are better adapted varieties for producing either grain corn or silage corn. Location is also a factor to be considered, even within the Belle Fourche Irrigation Project boundaries. The sandier soils along the Belle Fourche River bottomland warm up more rapidly in the spring. This enables the corn to begin growing sooner than on the clay upland soils where the temperature of the soil stays cool longer, retarding germination of the corn.

In variety trials conducted by the station for the last 3 years, 1952-54, the location of the trial on sandy or on clay soils has resulted in differences in yields for the same varieties as shown in table 2.

Consider Your Farm

Although it is not possible to prescribe a procedure for all fields where corn is produced, it is not

difficult to put the following principles into practice. These are suggested practices for irrigated land.

1) If the bottom leaves of the corn plants grown on the field stay a dark green throughout the summer, your present practices are probably satisfactory. If the leaves turn yellow before frost, a lack of nitrogen is indicated. Measures should be taken to correct the deficiency through improved rotations or use of fertilizer. Application of nitrogen fertilizer as late as the second cultivation is a good practice.

2) Forty to 60 pounds of nitrogen per acre is enough for corn except on extremely deficient soil. It is seldom that applications in excess of 100 pounds will be economical.

3) Apply the phosphate to other crops in the rotation rather than to corn.

4) Plant 18,000 to 20,000 seeds per acre. Space the kernels 8 or 9 inches apart in rows 38 inches apart. Plant slightly thicker for silage.

5) Plant seed of one of the better adapted varieties.