

Better Crops

WITH PLANT FOOD

Number 3—1968

25 Cents



**FALL-WINTER
FERTILIZATION
ADD\$
PROFIT-MAKING
TIME TO SPRING**

**...and
puts
MUSCLE
into
NPK
Teamwork**





"ALL LOADED TO GO, BUT . . ."

"BUT WHAT?"

" . . . but they said it'd be DRY this year!"

"WHO said?"

"Well . . . I don't remember . . . exactly . . . but spring sure started out dry this year."

Yep, early spring can come in like a friend. But the friendship can break up fast by early May—the \$100-an-hour time—when unpredicted rains conspire to keep farmers out of the field 3 or 4 weeks. Planting delays play havoc with corn and soybean yields and profits.

Some day EXACT 2-week forecasts may become possible through satellite-fed weathermen—so exact, in fact, a grower may be able to exclaim, "They SAID it'd be dry and it WAS!"

But don't hold your breath or your fertilizing until then—or even after then. Forecasting two weeks exactly will not change the weather. The rains will come. The droughts will come. And farming's proud push will continue to press top growers. Fertilizing year-round—including fall and winter, when weather and time permit—is a good policy for today's hydramatic agriculture.

In this issue of BETTER CROPS, some leading scientists consider the opportunities and precautions in a year-round fertility program. Issue chairman was Dr. Werner Nelson, Senior Vice President of the American Potash Institute.

s.m.

Better Crops

WITH PLANT FOOD

The Whole Truth—Not Selected Truth

Published Quarterly by
The American Potash Institute Inc.

1649 Tullie Circle, N.E.
Atlanta, Georgia 30329

Sanford Martin, Editor
Selma Bushman, Assistant Editor
Barbara Martin, Circulation

Vol. LII No. 3 1968
Copyright 1968 by American Potash Institute

\$1.00 per year, 25¢ Per Copy

Controlled circulation postage
paid at Washington, D. C.

AMERICAN POTASH INSTITUTE, Inc.

Headquarters:

J. F. Reed, President
R. T. Roberts, Sec. & Admin. Asst.
E. D. Dixon, Asst. Treasurer

Vice Presidents:

W. L. Nelson, Sr. Vice Pres., W. Lafayette, Ind.
K. M. Pretty, Vice Pres., Port Credit, Ont.
R. P. Humbert, Vice Pres., Los Gatos, Calif.
S. E. Younts, Vice Pres., Atlanta, Ga.

Regional Directors:

W. K. Griffith, Reg. Dir., Silver Spring, Md.
R. D. Munson, Reg. Dir., St. Paul, Minn.

Agronomists

N. D. Morgan, Shreveport, La.
Forrest S. Fullmer, Newport Beach, Calif.
Grant Braun, Portland, Oreg.
C. B. Kresge, Columbus, Ohio
John Ronald George, Ames, Iowa
W. R. Thompson, Jr., Starkville, Miss.
N. R. Usherwood, Champaign, Ill.
D. W. Eaddy, Raleigh, N. C.
J. D. Romaine, Consultant

MEMBERS

American Potash & Chemical
Corporation
Cominco American Incorporated
Duval Corporation
International Minerals &
Chemical Corporation
Potash Company of America
Potash Company of Canada
Southwest Potash Corporation
Texas Gulf Sulphur Company
United States Borax & Chemical
Corporation

CONTENTS

GUARD AGAINST DROUTH INDUCED NUTRIENT HUNGER

Lloyd Dumenil and Ron George

2

WHEN IS YEAR-ROUND FERTILITY GO?

... IN THE MIDWEST

Harry M. Galloway

7

... IN THE SOUTH

P. J. Bergeaux

10

... IN THE NORTHEAST

V. A. Bandel

13

TURN TIME INTO MONEY AT PLANTING

W. W. Nelson

16

PRACTICE FLEXIBLE FERTILITY: BURY DELAYS

Stanley A. Barber

18

NITROGEN HANGS ON

21

WHAT ABOUT FERTILIZING VEGETABLE CROPS IN FALL AND WINTER?

J. F. Bartz

22

TWO PROS TALK

James M. Eller
Edgar M. Urevig

26

PROFIT POINTERS TO PONDER

30

FALL-WINTER EDUCA- TIONAL AIDS

COVER 3

Guard Against DROUTH INDUCED Nutrient Hunger

WITH . . .

- Early Applied N
- Plowdown Fertilizer
- High P-K Soil Test Levels
- Deep Plowed Nutrients
- Foliar Applications
- Mulch Tillage
- Irrigation Where Practical
- Narrow Rows, etc.

LLOYD DUMENIL
IOWA STATE UNIVERSITY

RON GEORGE
AMERICAN POTASH INSTITUTE

PLANT NUTRIENTS are more available in the plow-layer than in the subsoil of most soils.

Look at the typical Iowa soils in **TABLE 1**. Below the plow-layer, available phosphorus (P) drops off rapidly in many of them, potassium (K) in most of them—even in soils testing very high in the top 6 inches!

Watch out when the plow-layer begins to dry out. Nutrients tend to become unavailable. Nutrient stress sets in. Yields suffer along with profits.

MOIST SOIL IS VITAL. Plant roots need it to absorb nutrients. All three mechanisms for nutrient absorption rely on water:

Root interception—Calcium (Ca) and magnesium (Mg)—roots grow to more nutrients in a moist soil.

Mass-flow—Nitrate (NO₃), sulfate (SO₄), Ca, and Mg—nutrients are carried to the root surface with the soil moisture.

Diffusion—P and K—movement over a very short distance to the root thru thin water films over soil particles.

CALCIUM and MAGNESIUM availability normally increases with soil depth in more arid areas where plow-layers are more likely dry. In more humid regions, Ca and Mg nutrition is usually no problem when the grower follows a good liming program and uses a dolomitic lime or Mg-containing fertilizer on soils low in Mg.

But guard against Ca and Mg hunger cropping up on limed soils during extended dry weather. It can happen because available Ca and Mg are normally low in the acid subsoil of humid regions.

WHAT ABOUT NITROGEN? Most farmers blamed leaf "firing" on drouth 20 years ago. Now they know it was actually drouth-induced N deficiency, since drouth decreases N released from organic matter. Weather can greatly influence the efficiency of the time and method a grower uses to apply his N. For example:

Late Side-Dressed N, followed by sub-normal rainfall, is often stranded in dry

TABLE 1. SUBSOIL P AND K LEVELS FOR TYPICAL IOWA SOILS

Soil ¹	Pounds P or K per acre 6" layer ²							
	Av. P levels				Av. K levels			
	0-6"	6-12"	12-24"	24-36"	0-6"	6-12"	12-24"	24-36"
Floyd (24)	21	8	6	5	94	36	27	22
Fayette (22)	33	36	56	64	108	41	34	31
Clarion (15)	20	9	6	6	147	54	34	30
Tama (15)	29	10	18	34	238	62	42	36
Otley (9)	17	9	7	18	162	59	48	38
Seymour (17)	16	7	8	16	120	51	44	45
Shelby (13)	14	6	6	7	131	53	46	45
Marshall (54)	24	12	16	22	323	107	70	56
Monona (55)	18	9	10	15	225	71	53	47
Primghar (18)	19	6	5	5	201	63	50	38
Luton (8)	44	17	8	7	512	204	126	128

¹ Numbers of profiles tested in ().² P determined by Bray No. 1 test. K determined by ammonium acetate extraction from field moist samples.

Level	P (lbs)	K (lbs)
Very low	0-15	0-60
Low	16-25	61-125
Medium	26-45	126-200
High	Above 45	Above 200

soil near the surface, unavailable to rapid growing corn before silking in July.

Early Side-Dressed N, in late May or early June, may also be less efficient than pre-plant applications if both June and July are dry. Nitrification of high rates of banded ammonium-N rates takes 3 to 5 weeks. This slows movement of nitrate-N into the subsoil from side dressed N, so, just part of the nitrate-N may reach subsoil by drouth time.

Pre-Plant N, in fall or early spring, may often be the most profitable, especially in lower rainfall areas such as the western Corn Belt. There is rarely enough moisture to move much pre-plant N beyond the 3 to 4 foot depth on most Corn Belt soils, except in light sandy soils.

Movement of N out of the plow-layer can often benefit a corn crop, especially in dry weather. Take the southern Iowa drouth of 1953, for example. One trial had received N the PREVIOUS year. Some nitrate-N was in the subsoil, ready to help that crop use moisture more efficiently and produce far better yields than the newly initiated pre-plant and side-dressed N trials. Why? Because rainfall

after application was too low to move N out of the dry plow-layer to help the new trials.

WHAT ABOUT P & K? These two nutrients—phosphorus and potassium—are a bigger problem than N. They are immobile, for all practical purposes, though most P and K needs of the crop must be supplied by diffusion to the root.

In a typical Corn Belt soil, K might move ¼ inch in a growing season, P even less! They must be in the moist active root zone to do their vital job.

TABLE 2 shows how drouth will often reduce P and K uptake more than N. Why? Because P and K from manure, crop residues, and fertilizer normally remain in the plow-layer, while N from all sources moves into moist subsoil after nitrification to remain available long after plow-layer has dried.

PLACE THEM DEEP. Plowing under adequate amounts of fertilizer, especially immobile nutrients such as P and K, appears to be the best method for insuring crop nutrients at later growth stages.

TABLE 2. EFFECT OF MOISTURE STRESS DAYS ON ESTIMATED LEAF N, P AND K LEVELS DUE TO FERTILIZATION ¹

Fertilizer applied (lbs N + P ₂ O ₅ + K ₂ O)	Corn leaf content		% reduction due to dry weather
	No moisture stress days	Maximum number of stress days	
	— % N —		
0 + 160 + 50	2.0	1.5	25
160 + 160 + 50	2.9	2.2	24
	— % P —		
160 + 0 + 50	0.26	0.12	54
160 + 160 + 50	0.32	0.18	44
	— % K —		
160 + 80 + 0	1.1	0.7	36
160 + 80 + 100	1.6	1.2	25

¹ Data from Regis Voss Ph.D. thesis, Iowa State University, 1962 and for a Clarion, Nicollet or Webster soil testing very low in P and very low to low in N and K.

Research has frequently shown plow-down P and K increasing corn yields more than disked-in or row-applied P and K. FIGURE 1 and TABLES 3 and 4 tell the story. Lack of yield difference at the high P rate was due to the low stand that held back yield. And in the K trial, potassium was most limiting since there was little response to P until K needs of the crop had been met.

Corn leaf analyses confirmed the greater availability of the deeper placed P and K in both of these examples. On many soils this can mean fall fertilization and fall plowing to get set for early planting.

OTHER FACTORS AT WORK. Nutrient uptake patterns and time of drouth

influence occurrence and severity of drouth-induced nutrient deficiencies.

Uptake of N and P by corn closely parallels dry matter accumulation during the season. K uptake proceeds more rapidly, nearly complete by silking time. Late June or early July drouth decreases uptake of all nutrients, but late July drouth decreases N and P uptake more than K.

Restricted rooting from clay pans, highly acid layers, or poor drainage in the subsoil frequently prevents use of subsoil nutrients and water or delays their use too long for top yields. So, subsoil tests may not represent actual availability to plants. Nutrient and moisture stresses in corn are frequently accentuated in a dry July, if it has been wet in June, especially on more poorly drained soils.

TABLE 3. EFFECT OF METHOD AND RATE OF P APPLICATION ON CORN LEAF P CONTENT ¹

Method of application	Leaf % P for following P applications (lbs P ₂ O ₅ /A)		
	0	40	80
Plowed under	0.209	0.250	0.272
Disked in after plowing	0.211	0.240	0.255

¹ Dinsdale silt loam, Iowa, 1952. Yield without P-88 bu/A. Stand level—12,800 stalks/A. July rainfall—below normal.

MINIMIZE WITH MANAGEMENT.

Drouth-induced nutrient deficiencies are common in the western Corn Belt. Hunger for nutrients and thirst for water reduce crop yields in a drouth. But nutrient deficiencies usually occur earlier in the dry period than moisture stress. Extensive corn leaf analysis research work in Iowa has shown that yield losses often occur from drouth-induced nutrient deficiencies although moisture stress is not obvious.

Certain management practices can minimize but not eliminate the problem:

1—Apply N early. Avoid late side-dressing on all but sandy soils. In drier regions, either fall or spring pre-plant N is often best.

2—Plow under all or most P and K fertilizer. A small amount of row fertilizer for starter may be good for early planting and/or a cold, wet spring—side-band, split-boot, or pop-up. Row application may be best if P and K needs are low. But P and K applied in fall before plowing will be more profitable than after plowing.

3—Increase P and K soil test levels in plow-layer with higher fertilizer rate. This is vital for soils testing very low or low in these nutrients throughout the soil profile. Crops take up more nutrients from

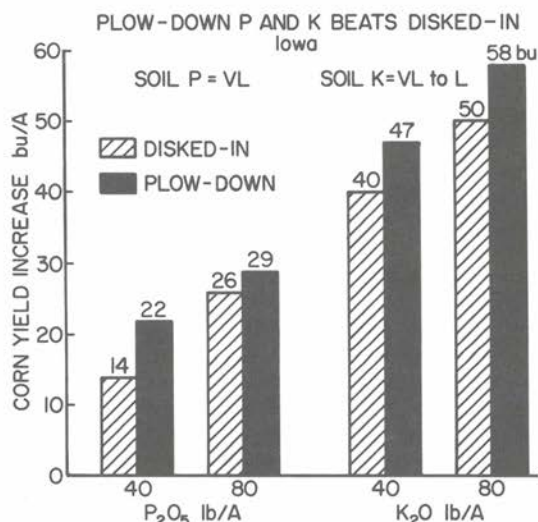


FIGURE 1

soils high in nutrients than from soils low in nutrients. These extra amounts will carry the corn an extra week or two in dry weather before nutrient deficiencies occur or become critically limiting. How fast and to what levels the P and K soil tests should be built depend on economics and the farmer's capital position.

4—Apply fertilizer deeper by plowing deeper occasionally. Get nutrients deeper in the root zone to be available in moist soil longer. It's not necessary to plow deep every year if P and K rates exceed the current year's needs. These higher rates also make up for nutrient di-

TABLE 4. EFFECT OF METHOD AND RATE OF P AND K APPLICATION ON CORN YIELDS AND LEAF P AND K CONTENTS ¹

Fertilizer applied (lbs P ₂ O ₅ + K ₂ O)	Method of Application	Yield (bu/A)	Leaf contents at silking	
			% P	% K
0 + 0	—	55	0.220	0.70
60 + 0	Plowed under	55	.338	0.66
	Disked in	53	.313	0.66
60 + 40	Plowed under	102	.292	0.99
	Disked in	93	.283	0.89
60 + 80	Plowed under	113	.272	1.28
	Disked in	103	.254	1.17

¹ Floyd loam, Iowa, 1952. Soil tests—low P and very low-low K. Stand level—13,800 stalks/A. July rainfall—below normal.

lution from the nutrient-deficient subsurface mixing with the plow-layer. Don't overlook extra limestone need as plowing depth increases. Many farmers do not now plow for corn after soybeans. These farmers need to plan ahead by applying enough P and K for both crops when they plow for soybeans.

5—Apply P and K 12 to 18 inches deep. Most past research conducted at low yield levels failed to show advantage for deep placement. But new research should shoot for higher yield levels, since the method in theory shows promise. Deep placement should boost yields under the following conditions: low subsoil fertility, good subsoil moisture early, and low July and August rainfall. Suitable equipment needs to be developed. Application cost will be high, so P and K rates should be high enough to last several years. Best time to apply might be in fall when subsoils are driest.

6—Foliar application of nutrients at critical growth stages and during stress periods may be profitable. More research is needed in this area.

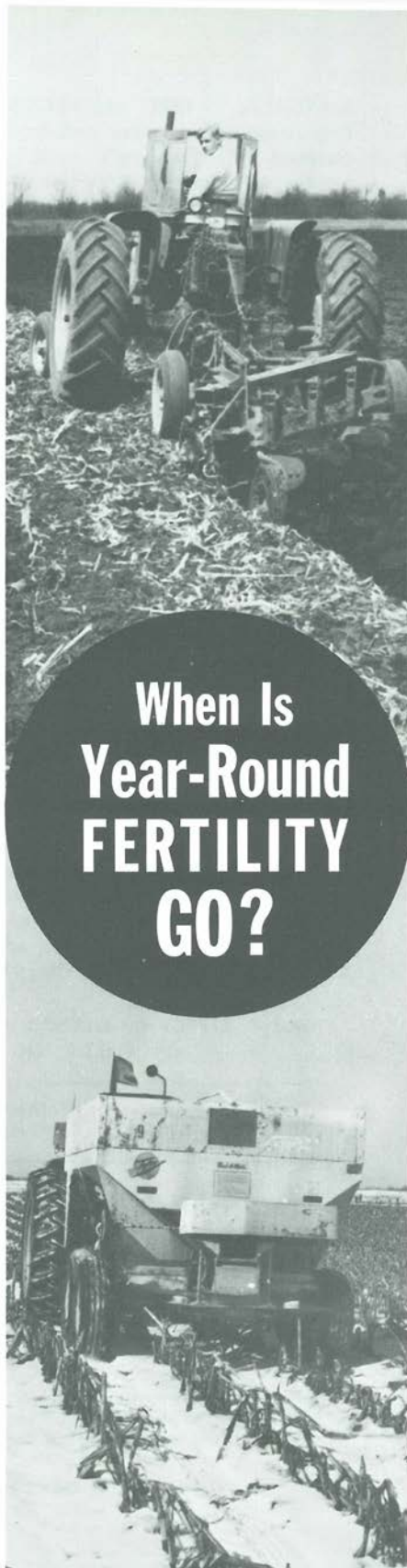
7—Mulch tillage, narrow rows, etc. may decrease surface evaporation of soil moisture, insuring moist plow layer for a few extra days.

8—Advantages of no-plow tillage systems may decline in dry seasons unless most of the P and K is applied as deeply as with plow-under systems. Residues accumulating near the surface should cause nutrients to accumulate there also, especially high amounts of K. Plowing may be necessary every few years to re-distribute nutrients in the plow layer.

9—Irrigate where opportunity exists. This essentially eliminates the problem of nutrients stranded in a dry plow layer.

THE END

NEWSLETTERS—COVER 3



**When Is
Year-Round
FERTILITY
GO?**



In The Midwest

Where more and more growers are looking at the opportunities and precautions of winter fertility.

HARRY M. GALLOWAY
PURDUE UNIVERSITY

FARMING MORE and more acres builds pressure. Today's managers seek all possible ways to increase efficiency.

Fall spreading P and K and plowdown have helped thousands of managers in recent years. They are also fall-applying ammonium forms of nitrogen on dark colored high organic soils.

Fall plowdown works well on non-erosive farms in years when the crops mature normally and the weather allows a long season for fall work. For two years now good late fall plowing weather has been scarce in the Central Corn Belt. To make up for this lost time, managers have begun to spread fertilizers in winter.

Winter fertilization may be well adapted on level farms, but risky on rolling farms—those we consider too steep for fall plowing.

Let's look at its agronomic possibilities: (1) the effects land slopes and soil surface conditions may have on keeping applied nutrients in place . . . (2) the effects al-

ternate freezing and thawing can have on nutrient absorption and retention . . . (3) the chances for winter spreading in three climatic belts.

BROADCAST P and K stay close to the surface. After first contact with soil surface in winter, P and K move very little into the soil. They probably remain in the upper half inch of soil until mechanically moved by plowing or spring planting operations.

In this position, they are vulnerable to erosion, especially during surface thawing at different times depending on latitude. Soft, puddled surface soils cannot resist the impact of rain drops and are very erosion prone.

Know Winter-Ready Conditions:

1—Corn residues, unchopped or chopped and spread—probably 2½ to 3 tons per acre.

2—Small grain stubble, seeded intercrop or winter cover crop.

3—Meadow ready to plow down or permanent pasture.

4—Soybean stubble (ready to go to corn).

5—Land that produced silage (the past season).

Heavy corn and small grain stubble and meadow or pasture all control runoff and erosion losses and help protect soil against excess freeze and thaw at the surface.

Surface applied nutrients should be relatively safe from wash-off on slopes protected by heavy residues during low intensity rains (up to 0.5 inch). Losses might be greater from heavier rains.

WHAT ABOUT WASH-OFF? Work with the Purdue-ARS rainulator (simulating rainfall) in southern Indiana indicates heavy storms can wash off much N under some conditions.

Two hundred pounds of N as ammonium nitrate was applied on two-inch fescue sod on strongly sloping Zanesville silt loam (13 percent) only one day ahead of a five-inch "storm." When the soil received an initial moisture content of 12.5 percent, only 5 pounds of N per acre

DAYS SUITABLE FOR SPREADING FERTILIZER DURING THE FROZEN PERIOD

was lost. But when soils reached 25.8 percent moisture—field capacity—30 pounds of N per acre was lost.

The largest concentrations came during the first one-tenth inch of runoff. Steadily decreasing amounts with less proportion of ammonium nitrogen appeared in later portions of the total 2½ inches of runoff. As the salts washed off the vegetation and over the soil, more of the ammonium nitrogen apparently found places to be absorbed on mineral and organic matter surfaces. While the study was made only on nitrogen it indicates what may happen to any nutrients applied.

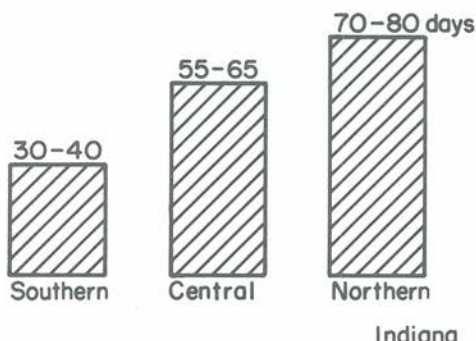
WHAT ABOUT EROSION? Soybean stubble fields and silage land with little residue, and with the usual compacted and sealed surface layers, may be a very poor place to put fertilizers in winter.

In the same rainulator study, runoff from fallow plots at field capacity (28 percent H₂O) and with a sealed surface layer reached about 2.9 inches from a total of five inches applied. N loss was only 14 pounds per acre—half that from sod. Without a sealed surface layer, only six pounds per acre was lost. Again concentrations of N were greatest in the first half-inch of runoff. While applied nitrogen losses were less than from sod ground, total nitrogen losses were much greater.

In the 17 tons of silt per acre lost from fallow ground, there were some 30 pounds of organic (soil) nitrogen and undetermined amounts of P and K. Since this work was performed in late fall on wet, but unfrozen soils (both sod and fallow), it indicates what may happen on very wet thawed soils of winter in the southern Corn Belt. **But remember: that with all our knowledge about erosion and nutrient losses in the crop and harvest seasons, we know little about the fate of fertilizers applied on frozen ground.**

Since erosion is a selective process, it removes more clays, silts, and organic matter early in a storm. Nutrients closely associate with these fractions, so we can expect greater concentrations in the eroded material than are common to the entire soil.

Studies over many years have shown N



concentrations in eroded sediments to be about 2.5 times, P about 3.4 times, and organic matter up to 4.7 times those in the original soil.

In many tests, K levels have averaged three times as high when considering total soil K and seven times as high in the eroded material when considering only the plant-available K levels in the original soil.

DON'T GENERALIZE erosion losses. Why? Because surface cover and slope conditions vary greatly across the Corn Belt.

Certain conditions point to safe winter fertilization:

- Generally level fields with low elevations and shallow swales and with short slopes not over four percent gradient, even with only thin residues for cover.
- Short slopes in the four to ten percent range, if residues are heavy and surfaces are cloddy or ridged.
- Longer slopes (over 200 feet), if terraced or strip cropped or tilled to have cloddy or ridged surfaces. A practical upper limit on these might be about eight percent even with good cover.

Wet, seepy slopes of the southern areas will be more dangerous because of frequent thaws, more winter rains, and unstable surface soil conditions common in winter. On very sloping sod meadows and pastures the practice will be safer if fertilizers can contact the soil surface before heavy rains arrive.

TABLE 1. DATES OF FIRST FREEZE AND LAST THAW AT FOUR-INCH DEPTH AND NUMBER OF TRAFFICABLE DAYS (FROZEN) AT THREE LOCATIONS, INDIANA

	Date of first freeze		Date of last thaw		No. days frozen *	
	Range	Avg.	Range	Avg.	Range	Avg.
Southern Indiana Forage Farm (South)						
Sod—(7 yr.)	12/13-1/26	1/5	1/20-3/25	2/23	0-49	26
	2 yrs. not frozen					
Bare—(6 yr.)	11/18-1/10	12/7	1/10-3/27	3/7	1-81	46
Purdue Agronomy Farm (Central)						
Sod—(7 yr.)	12/12-1/19	12/25	2/18-3/26	3/10	0-95	55
	1 yr. not frozen					
Bare—(6 yr.)	12/2-1/9	12/18	3/1-3/22	3/7	27-102	57
Pinney-Purdue Farm (North)						
Sod (5 yr.)	12/18-1/26	12/27	3/15-4/7	3/24	50-103	80

* Frozen at four-inch depth; number of trafficable days.

Rough surface conditions left by some of the newer tillage systems enable winter fields to absorb water much better. Systems leaving ridges between, or in the rows, or clods which can trap and hold snow and rainwater are very valuable.

HOW MANY SPREADING DAYS?

Even though we feel winter fertilization may be a safe practice, when can we get it on the land? Corn Belt climate varies from north to south in temperature, frozen ground, and winter rainfall. Three Indiana locations show these differences:

Southern Indiana Forage Farm records show wetter and warmer winters. For two years out of seven, sod ground did not

freeze at all. One year in six bare ground went unfrozen.

The freeze period averaged 50 days for sod ground, 91 days for bare ground. But the soil was frozen enough only half this time to make field work possible, shown in TABLE 1. After each sizeable rain, the ground thaws to four inches or more. It takes four to five days to freeze again to that depth.

The December 1965—February 1966 frozen period shows a southern Indiana wet winter: Eight inches of rain . . . only 45 days frozen at four inches under bare soil . . . 24 days under sod . . . six of the rains over 0.5 inches . . . three over one inch, causing prolonged wetness, low

TABLE 2. PROBABILITY IN DAYS PER MONTH OF VARIOUS AMOUNTS OF WINTER AND EARLY SPRING RAINFALL

	So. Indiana Forage Farm			Purdue Agronomy Farm			Pinney-Purdue Farm ¹		
	.10 in.	.50 in.	1.0 in.	.10 in.	.50 in.	1.0 in.	.10 in.	.50 in.	1.0 in.
	13 yrs.			14 yrs.			14 yrs.		
December	5	2	0.9	4	1	0.4	5	1	0.4
January	5	2	0.7	4	1	0.3	4	1	0.4
February	7	3	0.8	4	1	0.1	6	1	0.1
March	7	3	0.8	5	1	0.2	5	1	0.4
April	7	3	0.5	8	2	1.2	9	3	1.1

¹ Data from Valparaiso Waterworks Station.

traffic, and much erosion hazard on bare ground.

TABLE 2 shows the probable days and inches of winter and early spring rainfall. In southern Indiana, 30 to 40 days may be available for spreading fertilizer on bare seepy fragipan soils. On thick sods that can support loads during thaws and on sandier or better drained southern Corn Belt soils, more days may be available.

Central Indiana winters are intermediate at Purdue's Agronomy Farm. On a well drained soil, average freeze period runs 76 days under sod and 84 days under bare ground. On about 70 percent of these days, soil remains frozen and available to field work.

Rains of 0.5 inch or more, which can halt field work, are probable only once a month during winter. Chances of erosion-producing rains—1.0 inch or more—are probable only once in two years. There should be 55 or more days suitable for spreading in the frozen period. Such standards may change with the use of flotation tires 30-40 inches wide on spreading equipment.

Northern Indiana winters are colder, drier and more uniform at the Pinney-Purdue Farm near Lake Michigan. On a freely drained soil, average frozen period begins only nine days earlier than in southern Indiana. But the freeze period under sod lasts a month longer in spring. Data are not available for bare ground.

Freeze period averages 88 days, with ground frozen 90 percent of the time. Probabilities of 0.5 inches of rain or more are only three days during the frozen period. One inch or more of rain, threatening considerable erosion and loss of surface applied nutrients, is probable only one-third as often as in southern Indiana.

There should be 70 to 80 days for spreading.

THE END

SLIDE SETS—COVER 3



In The South

Where top farmers are asking the big question:

Should I or should I not apply enough fertilizer in fall-winter to make sure my soil is stocked with enough plant food to feed most of next year's crop, regardless of what the weather and hectic schedule is like at planting?

P. J. BERGEAUX
UNIVERSITY OF GEORGIA

IN MULE POWER days, many Georgia farmers had one fertilizer philosophy: "How little can I get by with?"

What little fertilizer they used was put in the row or in a band near the seed. Such spoon feeding produced low crop yields and did not build the fertility level of Georgia soils. So, most Georgia soils remained acid and infertile.

Today's farmer faces high priced labor, land and other high costs. He must seek lower production costs. One valuable production tool he has learned to use abundantly is fertilizer. Better fertilization practices have increased phosphorus and potassium soil levels, as shown by soil test surveys in FIGURES 1 and 2.

Soils testing low phosphorus declined

from 56% to only 16%, while those testing high phosphorus increased from 21% to 57%. Soils testing medium phosphorus showed little change, increasing from 23% to 28% during the period.

Soil potassium levels have not changed this drastically. But those testing low and medium K have changed significantly. Soils testing low potassium decreased from 65% to 35%, while those testing medium increased from 24% to 48%. Little change occurred in soils testing high potassium—ranging from 11% at the beginning to 17% during the 1965-66 period.

Soil test correlation experiments have shown very little direct response to added phosphorus and potassium fertilizer on soils testing high in these elements. To achieve high phosphorus and potassium soil levels, fertilization programs should include maintenance amounts of these two elements.

The amounts should be based on the crop grown, yield desired, and use of the crop—that is, corn grown for silage would need a higher rate, particularly potassium, than corn grown for grain.

TIME IS VITAL. The time a farmer applies his fertilizer is growing more important to him. Applying it at or near planting has been the traditional time. But modern farmers are looking at year-round possibilities these days:

- Because fertilizer industry facilities for supplying fertilizer are severely taxed at planting time. It is difficult for them to assure everyone delivery in the same short period.
- Because weather conditions do not generally encourage fertilizer applications. Soils are wet and spreader trucks have trouble.
- Because time is also a premium to farmers at this time. More acres per farm are being planted with less labor in many cases. There are just fewer days per acre to get the job done.

Many farmers are looking at late fall or early winter fertilizer applications for spring planted crops. Will this practice

Changes In Soil Phosphorus Levels

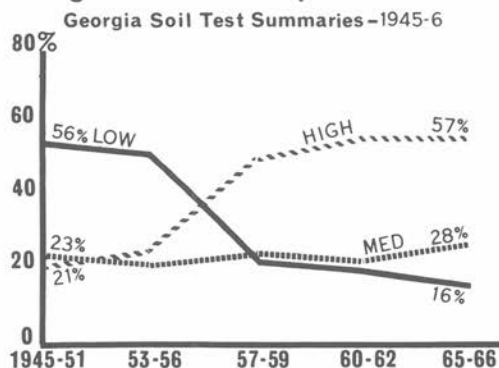


FIGURE 1

work in Georgia climate? Let's look at each fertilizer element singly.

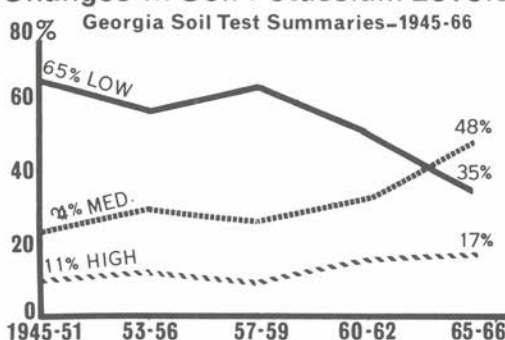
NITROGEN. When considering fall applied nitrogen for spring planted crops consider: (1) type of nitrogen, (2) winter soil temperatures, (3) amount of fall and winter precipitation, and (4) soil texture.

Type of Nitrogen: Ammonium or urea forms of nitrogen should be used for fall applications. These nitrogen forms (urea converts to the ammonium form in the soil) are less likely to leach than the nitrate form of nitrogen on soils containing good amounts of clay and/or organic matter.

Soil Temperature: Soil temperature is a big factor affecting oxidation of ammonium to nitrate. The lower the temperature, generally the slower the nitrification. Georgia Experiment Station Research Agronomists Anderson and Boswell found very little nitrification at soil temperatures of 42°F or below and rapid nitrification at 80°F.

FIGURE 2

Changes In Soil Potassium Levels



TEMPERATURE AFFECTS NITRIFICATION OF AMMONIUM NITROGEN

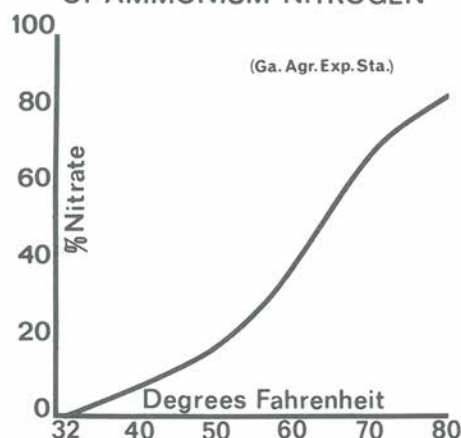


FIGURE 3

FIGURE 3 shows how temperature affects nitrification of ammonium nitrogen.

Georgia soil temperatures generally remain above 50°F most of the winter, except for the mountain area. Soil temperature six inches deep averaged above 55°F during December through March, according to 1966 climatic data at Tifton in the South. Under these climatic conditions, most ammonium nitrogen applied in fall will be converted to nitrate form and subject to leaching or denitrification loss before spring planting.

Georgia compared fall and spring applied nitrogen on corn. Fall applied nitrogen increased yields 12% as efficiently as spring nitrogen at the Coastal Plain Experiment Station, 48% as efficiently at the Piedmont Experiment Station.

APPLIED PHOSPHORUS tends to be fixed in the top few inches of soil. Little or no leaching loss occurs, especially on acid soils containing a high proportion of

kaolinitic clay. Most Georgia soils fit this category.

With 58% of its soils high in phosphorus and virtually no leaching problem, fall applied phosphate fertilizer should serve spring planted crops about as well as spring applied phosphate.

THE POTASSIUM ION, being a cation (K^+), is not as subject to leaching loss as nitrate nitrogen (NO_3^-). But it is more mobile than phosphorus in the soil. Applied potassium fertilizers leach very little on soils containing appreciable clay or organic matter. Some leaching may occur on coarse textured acid soils with a low cation exchange capacity.

Agronomists Boswell and Anderson measured the movement of applied potassium as potassium nitrate at varying dates from two soils. Most of the potassium was still in the top 2 feet of soil four months after application and after 27.0 inches rain on the Davidson soil, 10.3 inches on the Marlboro soil. Even after 12 months, none of the applied potassium moved below the 24 inch depth in the Davidson, though a small quantity moved below the 36 inch depth in the Marlboro soil.

These facts suggest potassium fertilizer can be applied up to 4 months before planting without major leaching loss.

The two soils used in this experiment represented Piedmont and Coastal Plain soil areas of Georgia. The Davidson soil, a Piedmont soil, contains more clay and is a finer textured soil than the coarser textured Marlboro soil of the Coastal Plains.

The Marlboro soils compare to the Tifton and Norfolk soil texture serving most of the cultivated Coastal Plains.

The Davidson soil compares to Cecil and Madison soil texture serving most of

TABLE 1. FALL VS. SPRING APPLICATION OF P_2O_5 AND K_2O ON COASTAL BERMUDAGRASS YIELDS. 1957-60. CECIL SANDY LOAM SOIL ¹

Time of Application	Fertilization Rate		Yields Per Acre (Oven Dried Forage)
	P_2O_5 -Lbs/A	K_2O -Lbs/A	
Fall	50	50	8695
Spring	50	50	9348

¹ 200 lbs. Nitrogen applied per acre

the cultivated and pastureland Piedmont.

University of Georgia Agronomist H. D. Morris found fall applied phosphorus and potassium—50 lbs. each—were not quite as efficient on Bermudagrass as an equal rate applied in the spring. TABLE 1 tells this story.

Today's high-cost farming forces good farmers to face a BIG question: **Should I or should I not apply enough fertilizer in fall and winter to make sure my soil is stocked with enough plant food to feed most of next year's crop, regardless of what the weather and hectic schedule is like at planting time?**

For those farmers who have increased their phosphorus and potassium soil levels to high and medium levels respectively, the sign is GO—especially on soils with much clay or organic matter.

Nitrogen is a different story. It's more subject to being lost from the soil than P and K. Nevertheless, some farmers may decide they had rather risk some nitrogen loss in order to get the bulk of it on, than to gamble with the possibility of not getting any of it on next spring.

It's a big question. But men who question—especially men who question themselves—are thinking. And thinking leads to know-how. And know-how leads to success.

THE END



In The Northeast

Where many growers are weighing profit-geared alternatives:

Possible loss of some nitrogen over winter OR wet soils and lack of time to apply any nitrogen at all next spring.

V. A. BANDEL

UNIVERSITY OF MARYLAND

THINKING ABOUT plowing down a complete fertilizer this fall in preparation for planting your corn crop next spring?

Many farmers now consider this practice. To minimize possible nitrogen losses, they realize they must follow certain rules. There are good reasons for and against fall application of complete fertilizers to corn stubble.

- Some fall fertilization helps spread out the farmer's seasonal workload, allowing him to make more efficient use of his labor and equipment.

- Fall fertilization spreads out the fertilizer delivery season relieving some of the tremendous pressure facing industry in spring when most of their deliveries are made.

But the farmer himself must decide largely whether or not plowing down a

**COVER 3
NEWSLETTERS
FOLDERS
SLIDE SETS
NEWSPAPER AD MATS
PLACE MATS
WANT AD—RADIO SPOTS
COVER 3**

complete fertilizer six or seven months ahead of planting time will really pay:

● Would soil erosion be a serious problem for him?

● Would the plant food plowed down in fall still be available to plants the following spring and summer?

LOOK AT FALL PLOWING. The farmer must decide if fall plowing would be practical on his farm. In Maryland, soil erosion is often a problem on fields that have been stripped of their cover.

In the Piedmont and Mountain sections, very few agriculturally important soils occur on slopes of less than 2 percent. Thus, soil erosion losses can be serious if appropriate conservation measures are not taken.

On the Coastal Plain, many soils are light or sandy. These soils are highly susceptible to wind erosion without adequate cover crop.

Some Maryland soils almost require fall plowing to prepare a good seedbed. Some of the more poorly drained soils remain too wet to plow early in the spring. Some heavy soils high in clay content often plow better in fall than in spring. Wind and rain action, freezing and thawing over winter reduce the hard clods to small aggregates, making easier seedbed preparation in spring.

Some fairly extensive and agriculturally important soils in Maryland do not fit in well with fall plowing. Some of the more poorly drained soils, low in organic matter and clay but high in silt or sand, tend to break down so badly under freezing and thawing that soil particles flow together and form a hard thick crust. When fall plowed, these soils quite often need to be re-plowed the following spring. Research indicates generally no

big yield difference between fall and spring plowing.

LOOK AT P & K. A long accepted practice has been to apply phosphorus and potassium in fall on all but the most sandy soils. Except in very light sandy soils, phosphorus and potassium will usually remain where placed with little or no leaching before spring. On light sandy soils, with low cation exchange capacities, potassium leaching could be a problem.

For some crops, there are definite advantages to fall fertilization. In University of Maryland trials, fall applied 0-1-1, 0-1-2, or 0-1-3 ratio fertilizers on alfalfa produced yields equal to spring or summer application. In fact, no major yield differences occurred between fall and spring fertilization.

LOOK AT NITROGEN. Fall seeded small grains usually respond to a small amount of starter fertilizer drilled in the row with the seed. But high levels of fall applied nitrogen are not recommended since this can cause excessive vegetative growth and winter killing.

On small grains, nitrogen is used most efficiently when applied in late winter or early in the spring just as the young plants are beginning to grow.

Research on nitrogen topdressing of orchardgrass in Maryland showed yields and nitrogen recovery were highest the closer application time was to harvest time.

But what effect would fall nitrogen application have upon corn yields? Unlike phosphorus and potassium, under favorable conditions, nitrogen in the soil is converted to nitrate form which is soluble and subject to serious leaching losses.

TABLE 1. CORN GRAIN YIELDS—BUSHELS PER ACRE AT 15.5% MOISTURE

Treatment	Urea	Ammonium Sulfate	Ammonium Nitrate	Sodium Nitrate	Average
Fall plow-down	115.1	112.8	114.3	109.7	113.0
Spring plow-down	116.6	119.1	118.0	116.7	117.6
Spring disc-in	106.6	116.1	111.0	113.2	111.7
Average	112.8	116.0	114.4	113.2	

TABLE 2. NITROGEN RECOVERY—POUNDS PER ACRE OF NITROGEN

Treatment	Urea	Ammonium Sulfate	Ammonium Nitrate	Sodium Nitrate	Average
Fall plow-down	104.8	99.9	104.7	101.7	103.3
Spring plow-down	102.8	122.8	103.2	104.4	108.2
Spring disc-in	99.7	105.6	91.8	101.8	99.7
Average	102.3	109.3	100.6	102.6	

Plow treatment LSD = 3.1 lb.
0.10

Research, begun in Maryland in 1964 to compare fall and spring applied nitrogen effects on corn yields and nutrient recovery, has not yet been conclusive. A big reason for lack of response was the unusually dry winter of 1964-65 and the complete crop failure from summer drought of 1966. Data collected from the 1967-68 plots should help strengthen our conclusions.

Maryland fall fertilization tests are comparing four sources of nitrogen: urea, ammonium sulfate, ammonium nitrate, and sodium nitrate. All four sources were either plowed down in fall, plowed down in spring, or disced-in in spring after plowing.

TABLE 1 gives the grain yields from one of the three locations in 1965. Typical of results from most locations, these data came from plots on a Manor loam in the Piedmont region.

Neither the source of nitrogen nor the time or manner it was applied significantly affected yields. But a trend indicated nitrogen plowed down in spring tends to produce higher yields than nitrogen plowed down in fall or disced-in in spring after plowing.

TABLE 2 shows nitrogen recovery

from these same plots. Notice nitrogen recovered by corn in spring disc-in treatment was inferior to either of the plow-down treatments. The 1964-65 season was unusually dry, with apparently insufficient moisture to move disced-in nitrogen down to the root zone.

Lack of normal precipitation may also explain why fall nitrogen applications seem to perform equally as well as spring applications in 1964-65.

In 1966-67, the experiments included a check plot. TABLE 3 shows grain yields from one test located on a Sassafras loam soil on the upper Eastern Shore.

The check plots received about 20 pounds per acre of nitrogen in the row. The other plots each received about 140 lbs/A of nitrogen total with 120 lbs. per acre applied in broadcast application.

Again, there were no yield differences due to nitrogen source or to application time. The relatively high check plot yields indicate possibility of some carry-over nitrogen, possibly due to the dry years. There was a significant difference in yield between the check plot and the

TO BANDEL—PAGE 25

TABLE 3. NITROGEN SOURCE

Plow Treatment	Urea	Ammonium Sulfate	Ammonium Nitrate	Nitrate of Soda	Mean (1)	Check	Mean (2)
Plow-down Fall	128.2	125.8	122.0	125.0	125.3	101.8	120.6
Plow-down Spring	129.0	132.2	129.1	131.4	130.4	97.1	123.8
Mean Nitrogen	128.6	129.0	125.5	128.2		99.5	

LSD For Nitrogen = 6.4 bu.
.05

(1) Average of plots receiving nitrogen. (2) Average includes check.

Turn *time* into

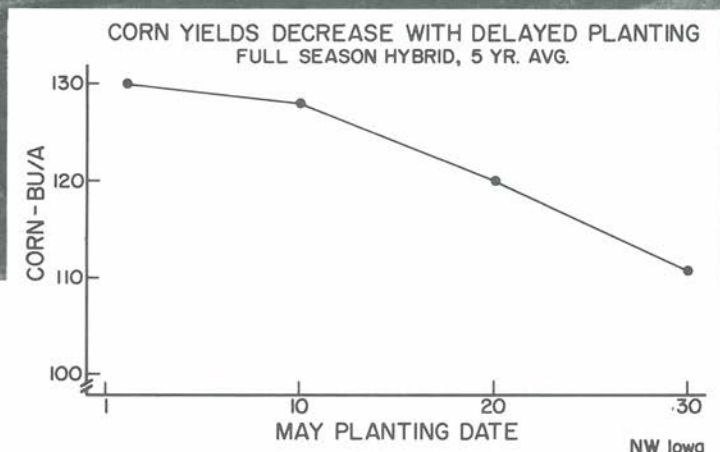


FIGURE 1

AS SPRING planting time arrives in the northern corn belt, farmers must be **READY** to plant. Timely planting pays big yield dividends with today's hybrids, herbicides, insecticides, and fertilizers.

HOW MANY DAYS? TABLE 1 shows a 5-year study of planting days in May at the Southwest Experiment Station, University of Minnesota, Lamberton, using a six-day week. This was mainly on Nicollet-Webster soil with tile drainage.

Always figure on slightly fewer days than average to line up help and equipment for getting the job done and determining the days in which it must be accomplished. During May about half the days can be used to plant. But the

TABLE 1—CORN OR SOYBEAN PLANTING DAYS—LAMBERTON, MINNESOTA

May	5 yr. ave.	Range
1-10	4	0-8
11-20	5-3/5	4-8
21-31	5-4/5	1-9
Total	15-2/5	8-20

range over five years varied from 8 to 20 days.

TIME OF PLANTING. A five-year study in northwest Iowa, conducted by Kenneth Ross, Superintendent of Northwest Iowa Experimental Farm, shows how timely planting boosts yields. In FIGURE 1, delayed planting—from May 2 until May 30—decreased the yields of a full season hybrid 19 bushels per acre,

MONEY at planting



W. W. NELSON

**SOUTHWEST EXPERIMENT
STATION**

MINNESOTA

or about .68 bu. per day. Some years the decrease exceeded a bushel per acre per day, though yield declined greatest after May 10.

If a farmer had 200 acres of corn and used the average yield for the periods shown, four days the first ten days of May would pay him five bushels per acre more . . . or 1,000 bushels . . . or \$1,100 more at \$1.10 per bushel than four days in the second ten days of May. Compared to the last ten days of May, his average yield advantage would be 13.5 bushels per acre more . . . or 2,700 more bushels . . . or \$2,970 more at \$1.10 per bushel! With this 200 acres of corn planted in four days, the farmer's time is worth \$750 more per day in increased corn yields the first ten days of May than the last ten days.

INCREASED VALUE OF PLANTING TIME PER DAY
- FIRST HALF OF MAY OVER LAST HALF

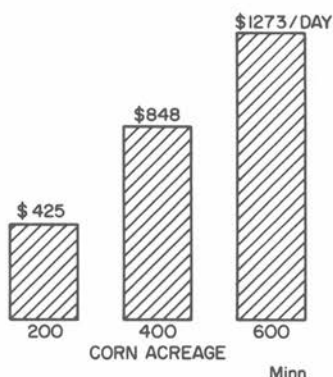


FIGURE 2

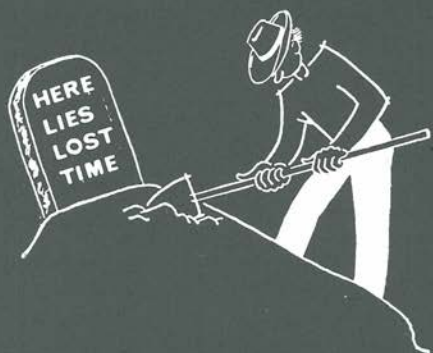
First year results of a 1967 corn management study at the University of Minnesota, Lamberton, showed similar yield trend. Planting the first half of May produced 13.5 more bushels per acre than the last half—coincidentally the same yield difference found in the Iowa work.

What would this yield difference pay on 200, 400, and 600 acres? FIGURE 2 shows how much more valuable a day's time is worth the first half of May than the last half. About seven planting days are available the first half of May. They are worth \$425 more with 200 acres of corn than in the last half, \$848 per day with 400 acres, and a whopping \$1,273 per day with 600 acres. This assumes farmers equip themselves to plant this

TO NELSON—PAGE 25

NPK: How Often?

Practice FLEXIBLE Fertility



BURY DELAYS!

STANLEY A. BARBER
PURDUE UNIVERSITY

FLEXIBILITY is the key to timing fertilizer applications.

When NPK applied several months before planting can be as effective as planting time applications, we can build flexibility into planning our fertilizer program. When we can make heavy applications once every two or three years, we build even greater flexibility.

This is important in today's crop production because we do not want fertilizer application to interfere with timing of planting, tillage, and other operations that greatly affect crop yield.

With today's higher fertilizer rates, we usually build and maintain soil fertility levels rather than fertilize the individual crop. This means application time has much less effect on the relative response to the added nutrients.

When low rates were used, fertilizer usually had to be applied while planting the crop or after planting, with N, to get the most efficient use. Few farmers use such low rates of fertilization in today's high-yield agriculture.

Even where the crop uses the fertilizer less efficiently, we may gain enough in convenience and economy of application to offset any efficiency losses. To evaluate the frequency and timing of NPK, we must know the relative effectiveness of alternate methods.

THE EVIDENCE. Recommended practices must be based on the evidence from research experiments. The following trials showed what may occur on a silt loam soil in the central part of the Corn Belt and on other Corn Belt soils.

A fertility experiment started in 1952 at the Purdue Agronomy Farm at Lafayette, Indiana shows how frequency of phosphate and potash application can affect crop yields. A four-year rotation of corn, soybeans, wheat and hay was grown from 1952 to 1961. In 1962 the rotation was changed to corn, soybeans, wheat and corn.

Broadcast applications of phosphorus and potassium were applied before the first corn crop. Row applications were made for corn and wheat. Since the second corn crop received no direct phosphorus or potassium and was the fourth

TABLE 1. EFFECT OF TIME OF PHOSPHORUS APPLICATION ON CORN YIELD AND PHOSPHORUS CONTENT OF THE EAR LEAF IN A CORN (1)-SOYBEANS-WHEAT-CORN (2) ROTATION

Broadcast ** and plowed under before corn (1)	Fertilization of Rotation				Av.* yield of corn (1) corn (2) bu. per acre		Av.* phosphorus in ear leaf of corn (1) corn (2) % P	
	(1)-soybeans	wheat-corn	(2)					
	lbs. P	per acre						
0	0	0	0	0	128	127	0.23	0.22
0	11	0	33	0	141	144	0.27	0.29
0	22	0	66	0	145	144	0.31	0.33
88	0	0	0	0	145	143	0.31	0.29
44	11	0	33	0	142	145	0.31	0.32
175	0	0	0	0	141	141	0.34	0.34
175	11	0	33	0	144	144	0.36	0.34

* Average for five years.

** $P \times 2.3 = P_2O_5$.

crop following broadcast fertilizer application it was used to learn how effective previously applied fertilizer had been. A few of the fertility treatments were selected to compare different methods of fertilization. TABLE 1 tells the phosphorus story, TABLE 2 the potassium story. The yields and P or K contents of the ear leaf are shown for the two corn crops for the period 1962-67.

TIMING P FERTILIZER. TABLE 1 shows essentially no difference between the yields of the two corn crops. Broad-

cast phosphorus maintained the yield for four years.

Phosphorus content of the leaf is a little more critical measure of the phosphorus nutrition of the crop. It indicates a small drop—from 0.31 to 0.29—in phosphorus availability where 88 lbs. of P (200 lbs. P_2O_5) were broadcast. All other values are similar between the two corn crops. These facts favor broadcasting all the phosphorus for corn once in 4 years on this Raub silt loam soil of pH 6.5.

Now many farmers will want to apply fertilizer more frequently. Also other soils

TABLE 2. EFFECT OF TIME OF POTASSIUM APPLICATION ON CORN YIELD AND POTASSIUM CONTENT OF THE EAR LEAF IN A CORN (1)-SOYBEANS-WHEAT-CORN (2) ROTATION

Broadcast ** and plowed under before corn (1)	Fertilization of Rotation							
	Row for corn (1)-soybeans-wheat-corn (2) lbs. K per acre				Av.* yield of corn (1) corn (2) bu. per acre		Av.* potassium in ear leaf of corn (1) corn (2) % K	
0	0	0	0	0	108	103	0.87	0.78
0	21	0	63	0	131	132	1.35	1.22
167	0	0	0	0	142	132	1.82	1.27
167	21	0	63	0	139	139	1.91	1.46
500	0	0	0	0	141	142	2.21	1.89

* Average for five years.

** $K \times 1.2 = K_2O$.

TABLE 3. EFFECT OF TIME OF NITROGEN APPLICATION ON CORN YIELD AND NITROGEN CONTENT OF THE EAR LEAF

N applied * in		Yield		N content of ear leaf	
first year	second year	first year	second year	first year	second year
lbs. N per acre		bu. per acre		%N	
0	0	94	66	1.69	1.32
60	60	117	113	2.07	1.80
120	0	121	104	2.35	1.57
120	120	132	133	2.34	2.24
240	0	133	125	2.48	2.00
180	180	125	133	2.41	2.40
360	0	128	138	2.45	2.24

* Plowed under before planting.

may not be as favorable. These facts emphasize the flexibility possible in timing phosphorus for corn.

TIMING K FERTILIZER. In the same experiment, we also had potassium treatments. TABLE 2 shows some of the treatments and results on the two corn crops. Broadcasting 167 lbs. of K (200 lbs. K_2O) per acre did not maintain the corn yield in the fourth year after application. A rate of 500 lbs. K per acre did.

The residual effect of 63 lbs. K applied for the preceding wheat crop gave results equal to one-third the amount applied for corn. The potassium contents of the ear leaf dramatizes the decline in potassium availability from the first to the fourth year.

These facts show how residual effects of potassium were less than those for phosphorus. Even so, they were effective where rates were high. It appears that potassium could be used once every two years.

TIMING N FERTILIZER. In research we have frequently compared fall, spring and sidedress nitrogen applications. We stretched this even further by applying nitrogen once every two years in continuous corn. We compared biennial applications with annual applications. TABLE 3 gives the treatments and their results. Although these facts cover a single experiment, they resemble many other experiments that show a residual effect from

applied nitrogen. There is a definite carry-over of nitrogen from one crop to the next.

Although annual applications were more effective than a single application every 2 years at low rates, there was little difference between 180 lbs. N per acre per year and 360 lbs. once every two years.

The data show there is much flexibility in nitrogen application on soils where some leaching occurred during the winter months.

IN SUMMARY. Nitrogen, phosphorus, and potassium may all be applied far in advance of use under many situations with minimum inefficiency.

Today's higher application rates allow much more flexibility in timing applications than lower rates once allowed.

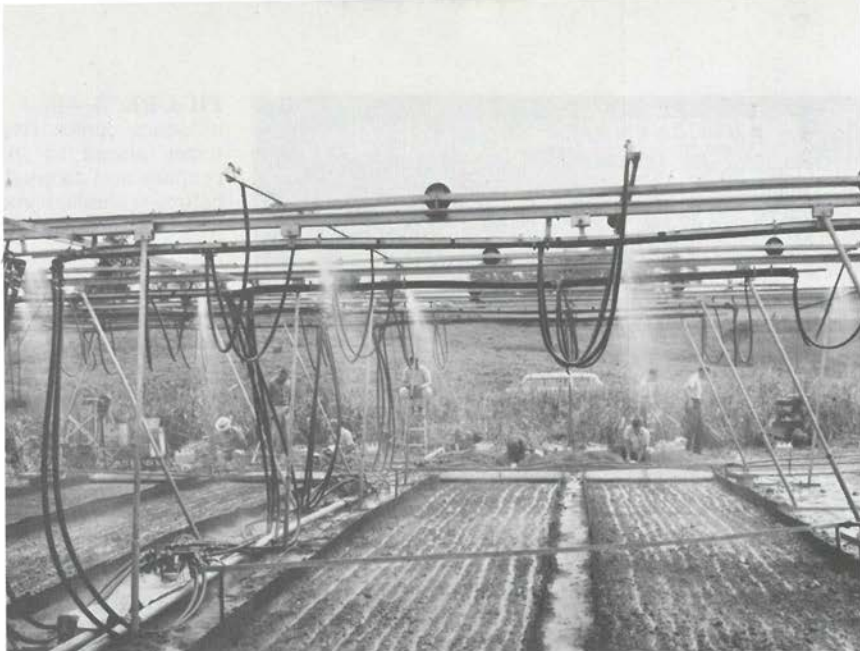
Fall-winter fertilization of next summer's corn crop should be considered as an alternative to applying most of the fertilizer at planting.

Watch all factors that influence the maintenance of the availability of nitrogen, phosphorus and potassium in the soil under your soil and climatic conditions.

Little P and K are lost by leaching and fixation is not great in many soils.

Early applied N may be subject to loss by denitrification or leaching. But the large residual carry-over of nitrogen from one year to the next indicates such losses are small on many soils.

THE END



RAINFALL SIMULATOR SHOWS . . .

Nitrogen Hangs On

HEAVY RAINFALL does not necessarily cause high runoff losses of surface applied nitrogen fertilizer. This was the major conclusion of field tests conducted at the Southern Piedmont Conservation Research Center, Watkinsville, Ga.

We broadcast granular ammonium nitrate fertilizer at the rate of 200 pounds of nitrogen per acre on fallow and sod plots. The plots were on sandy loam soils with a 5 percent slope.

One hour after the fertilizer application, 5 inches of rain at an intensity of 2½ inches per hour were applied with a rainfall simulator. We collected washoff samples and determined their nitrogen content.

We found considerably less runoff and erosion losses from the sod plots than from the fallow plots. In addition, only 0.15 percent of the applied fertilizer washed off the sod plots. On fallow plots, even though soil and water losses were relatively high, only 2.3 percent of the fertilizer washed off.

Apparently, the first few minutes of rainfall moved most of the soluble ammonium nitrate into the soil where it became relatively inaccessible to erosion processes.

The amount and intensity of rainfall (5 inches at 2½ iph) used in this study are likely to occur only once every 100 years. Therefore, losses resulting from more frequent, but less severe storms in normal years should be considerably lower.

These results indicate that ammonium nitrate fertilizer, when used under the conditions prevailing in this study, would be a relatively unimportant contributor to pollution of streams and rivers.

Future studies will be conducted on soils of different slopes and infiltration capacities to ascertain under what condition losses of fertilizer materials might be significant. (A. W. White, A. P. Barnett, and W. A. Jackson, Agricultural Research Service, U. S. Dept. of Agriculture, and V. J. Kilmer, Tennessee Valley Authority: In **CROPS & SOILS Magazine**.)

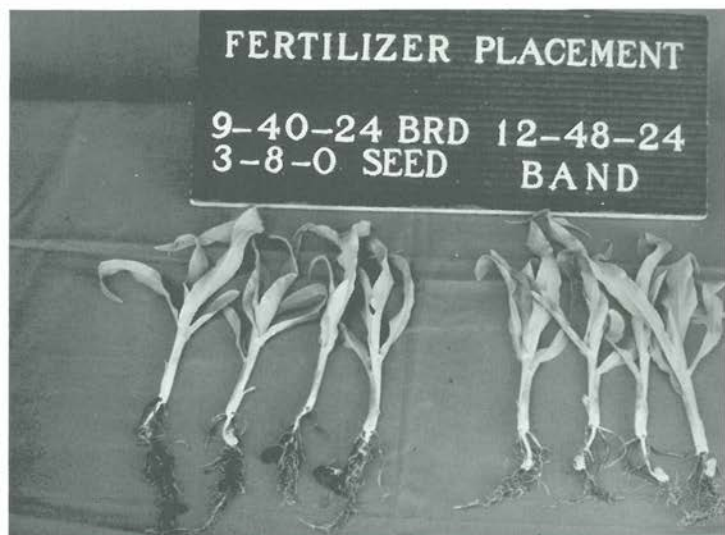


FIGURE 1—Best starter influence comes from fertilizer placed to intercept primary and seminal roots, before secondary roots are developed.

What Fertilizing vegetable

J. F. BARTZ
SENIOR AGRONOMIST
GREEN GIANT COMPANY

VEGETABLE CROP growers are looking at the idea of fertilizing several months ahead of crop needs in the Midwest.

Results with sweet corn have been very good, generally, while work with peas and snap beans suggests caution.

ON SWEET CORN. Though fertilizer needs of field corn and sweet corn are similar, sweet corn culture differs enough to justify special examination.

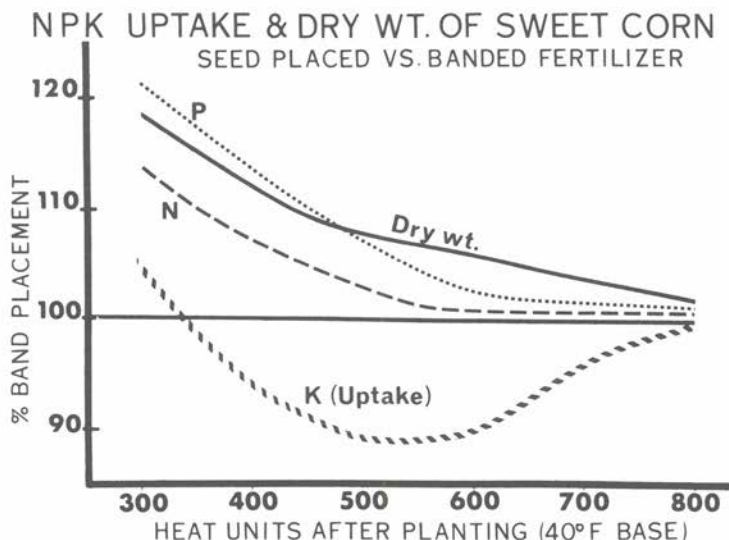
For example, sweet corn is planted from about May 5 to June 25, while most field corn is planted between May 1 and 20 in the same area. Sweet corn is harvested at an immature stage of growth when the kernel weight is changing very rapidly, so uniformity of plants is directly related to yield.

To satisfy the public, sweet corn is bred to contain a sugary rather than starchy endosperm and a thin, rather than thick seed coat—factors that make sweet corn a kind of “genetic freak.” Though plant breeders select hybrids for yield and vigor, quality dictates hybrids with less vigor and hardiness than current field corn hybrids.

BAND PLACEMENT. A big reason for using starter fertilizer is to encourage early uniform vigorous growth of plants. Nutrients banded two inches below and two inches to one side of the row normally intercept the secondary roots 10 to 14 days after planting.

Enough banded P and K fertilizer can be safely applied to replace nutrients removed by the crop. In addition, banded fertilizer is more efficiently used by the crop than that mixed with the soil.

FIGURE 2—Seed placed fertilizer (3+12+0) gives greater early growth than band placed nutrients (16+48+24).



About crops in fall & winter

WHY FALL FERTILIZER? If band placement accomplishes the goals above, why consider fall fertilization?

1—Consider the anatomy. At germination, both the primary and seminal root systems are fully functional before the secondary root system is initiated. So, for the most efficient starter influence, fertilizer should be placed where it is intercepted by the primary and seminal roots. With 2 x 2 band placement, fertilizer interception is limited primarily to the secondary roots, shown in FIGURE 1. Deeper plow-down may improve root growth and distribution during periods of moisture stress.

2—Consider the climate. Rainfall distribution in the Midwest is such that available soil moisture is limiting, especially in the surface soil, during some period almost

every season. In TABLE 1, radiophosphorus placement studies show how 2 x 2 band placement alone delays root development into soil layers below 8-10 inches.

3—Consider total plant needs. Purdue workers have reported nutrient uptake from band placed fertilizer is limited to

TABLE 1—FERTILIZER INFLUENCED ROOT DEVELOPMENT OF SWEET CORN.

Plant Growth Stage	Fertilizer placement	Root activity ¹ —%
7 to 8 leaf	broadcast	35
	2 x 2	9
Layby	broadcast	108
	2 x 2	52
Harvest	broadcast	141
	2 x 2	105

¹ Measured by radiophosphorus placed 12 inches deep.

Non-fertilized check = 100 percent.

TABLE 2—FERTILIZER PLACEMENT AND YIELD OF SWEET CORN ¹

Fertilizer Placement ²	Sweet corn yield
	Tons/A
Band	7.8
Seed + fall plowdown	7.8
Seed + band	8.0
Seed + band + fall plowdown	7.9

¹ Average of three planting dates and two locations.

² Total nutrients applied were 16 + 48 + 24 (N, P₂O₅, K₂O) for first three treatments and 32 + 96 + 48 for fourth. Seed placement rate was 3 + 9 + 0.

the first third of the growing period. During later stages when growth rate and nutrient needs are both high, banded fertilizer supplies very little crop needs.

4—Consider the economics. Time is money to a processor and his growers. Planting must be done on rigid schedules in well prepared seedbeds. During planting, any associated operation that tends to reduce the number of acres per hour is costly! Schedule delays or lower yields from nonuniformity of planting in poor seedbeds is costly!

Studying all these factors under field growing conditions, Green Giant Research has shown these results:

1—Seed placement of starter fertilizer gives greater early growth than band placement, shown in FIGURE 2. Row width is an important factor in choosing rate of seed placed fertilizer.

2—Yields from fall plow-down plus seed placement of starter fertilizer equal band placement, as shown in TABLE 2.

3—Low rates of seed-placed starter fertilizer are as effective as higher rates.

TABLE 3 shows how higher rates tend to delay emergence and upset the potassium balance in the seedlings. Potassium was not included in the seed applied fertilizer for this study because of the relatively high salt index of potassium materials. In recent Wisconsin trials, 3 lbs./A potassium stimulated seedling response where soils were medium in exchangeable potassium.

ON PEAS. They have a shallow root system. They are planted in "cold" soils (42-50°F). So, it pays either to place the fertilizer with the seed at planting or broadcast and work it in before planting in the spring.

It may be possible to apply this fertilizer any time during the winter months on level or rolling slopes where snow cover and spring runoff are not deterrents. Seed placement would likely be best year in and year out.

ON SNAP BEANS. Most snap beans in the Midwest are grown on coarse-textured soils under irrigation. In addition, present mechanical harvesters require wide row widths that allow little or no root cross feeding. For these reasons, preferred fertilizer placement for this crop is in a band 2-3 inches from the row and 2 inches below the seed.

In conclusion, Green Giant Company research recommends fall fertilization wherever practical for sweet corn, with spring (or possibly winter) fertilization for peas. Snap beans should be fertilized at time of planting.

THE END

TABLE 3. SEED PLACED FERTILIZER RATE AND GROWTH OF SWEET CORN.

Seed placed fertilizer—lbs./A.					Growth and nutrient uptake ¹			
N	+	P ₂ O ₅	+	K ₂ O	Dry wt.	Mgm N	Mgm P	Mgm K
					Percent of banded fertilizer ²			
1.6	+	6.0	+	0	144	165	285	130
6.4	+	24	+	0	80	102	240	60

¹ Measured 20 days after planting in greenhouse.

² Band placement of 250 lbs./A. 8-32-16 equal to 100 percent.

other nitrogen treatments. There was no significant yield difference due to fall or spring plowing.

Though not significant, the yields reflect the probability of some nitrogen lost from all nitrogen sources over the winter. But the least losses occurred from urea. This trend was present most years and at most locations.

KNOW YOUR RULES. Fall vs. spring nitrogen fertilization work in Maryland suggests in some cases certain kinds of nitrogen might be plowed down in fall with minimum losses. But, to be safe, the following rules must be observed closely:

1—The soil must not be subject to serious erosion losses.

2—The soil must be of a medium to a heavy texture (loams, silt loams, clay loams, etc.). Light sands to be planted to corn the following year should not be plowed in fall or fertilized with nitrogen or potassium in fall.

3—Apply nitrogen only after the soil temperatures have permanently dropped to 45° F. or below.

4—Use only urea or the ammonium form of nitrogen.

Excessive or normal precipitation over the winter may cause more serious nitrogen leaching than our tests have shown to date.

These experiments are being continued in 1967-68 at four locations in Maryland. We hope data collected this year will help develop more definite conclusions about fall nitrogen fertilization of corn.

It has long been accepted as a safe practice to apply phosphorus and potassium in the fall on all but the most sandy soil.

THE END

ADVERTISING MATS—COVER 3

acreage in the allotted time or slightly less.

WHAT ABOUT SOYBEANS? With a corn-soybean farm, timely soybean planting is also vital for yields. FIGURE 3 shows yield advantage of planting beans the last half of May compared to the first half of June. Delayed corn planting pushes back soybean planting, compounding the losses suffered by delayed corn planting.

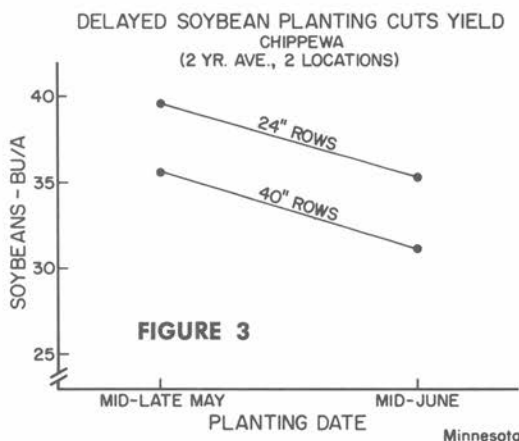


FIGURE 3

A GOOD BONUS. Minnesota trials showed a full season hybrid planted on time is mature and ready to harvest earlier in the fall. This enables a grower to harvest, fall fertilize, and plow during good weather. Also, as in 1967, the late May planting was caught by frost and had to be used as wet corn.

The total year's work and crop are tied to an amazingly few days. It's easy to see why the value of planting time may be worth from \$50 to \$150 per hour more the first half of May than the last half.

A farmer's machinery, fertilizer program, herbicides, etc., must match the job he has to do. It's a race with the calendar. Good management of time and effort is critical. Any techniques, such as fall-winter fertilization, used to ease the work load during the spring planting season will pay big dividends.

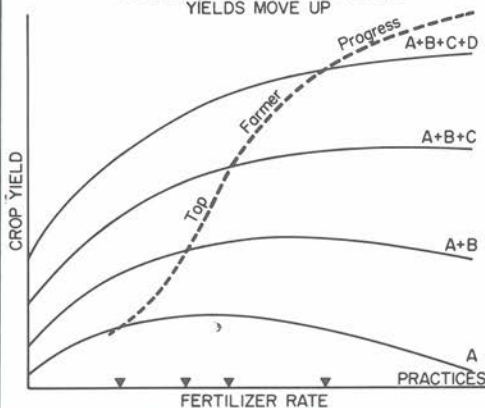
THE END

TWO PROS TALK

OF PROFIT-MAKING
PRACTICES IN
1968

TOP FARMERS KNOW THEIR ABC'S

AS FARMERS ADOPT NEW PRACTICES
OPTIMUM FERTILIZER RATES AND
YIELDS MOVE UP



THE 8500-ACRE Chance Farm, located on Brazos River bottom alluvial soils of Burleson County, grows corn and grain sorghum (milo) for profit!

We use the same steps to produce both crops:

Flat break at deep depths.

Put on high fertilization rates, all applied pre-plant.

Grow narrow rows with high plant populations.

Plant early with best full-season varieties available.

Broadcast herbicide application with no mechanical cultivation.

Acreage of corn production in Texas has dropped yearly for many years, yet good corn markets are here. The Chance Farm plants both corn and sorghum for diversification and to space out both planting and harvesting operations. Since most

JAMES M. ELLER

EDGAR M. UREVIG

DO YOU BULK SPREAD, apply at planting, or sidedress your fertilizer in spring? If so, why?

Unless you have some special reason, *it may pay you well to fertilize in the fall or winter.* New varieties, seed treatment, better drainage all allow earlier planting in the spring.

In our area, corn should be planted no later than May 12. We average only 13 work days in May, allowing about 6 work days for field preparation and corn planting. Any work we can do in fall or winter usually saves time and makes dollars.

SOIL COMPACTION can be a serious offender in spring. This is another plus for fall or winter fertilization. Spreading equipment on wet soils in the spring causes compaction and ruts.

If soil compaction occurs in the fall, it will be partially corrected by freezing and thawing. Spring compaction may remain throughout the season.

of irrigated acreage is planted in cotton, grain production here is predominately a dryland operation.

DEEP PLOWING PAYS. Beginning with stalk destruction after the July-August harvest, a base, dry, homogenous, broadcast fertilizer application is made (usually 50-100-50) with trace elements. We plowdown this application with moldboard and disc plows drawn by a crawler tractor.

One year disc plowing is done about 8 inches deep, followed by chiseling. The next year the field is plowed with a moldboard plow usually 18 inches deep, sometimes to 24 inches.

These practices have eliminated hardpan problems, stimulating better yields on both dryland and irrigated fields from better water use by deeper rooting and deeper fertility.

NARROW ROWS BEST. Although great increases have been obtained from narrow rows, much of the 1968 grain land was bedded into 40-inch rows. Sorghum was planted here with two drills per row, 12 inches apart on the 40-inch beds, and in 20-inch drills where the land has been left flat.

When all planting equipment has been converted to precision-type planters that can be set on a 20-inch spacing, we plan to plant all sorghum acreage on 15 to 20-inch spacing, shooting for 130,000 plants per acre.

Deep plowing has helped prevent flat land from being too wet at planting, eliminating bedding need in many fields.

We planted corn in 40-inch rows in 1968, but as soon as our combine headers can be converted to 20-inch spacing we will plant corn in 20-inch drills, also. We
TO ELLER—PAGE 28

GENERAL MANAGER, THE CHANCE FARM, TEXAS

GENERAL MANAGER, THE TILNEY FARMS, MINN.

Applying fertilizer in fall assures having the job done and being ready to go in the spring.

EXTRA SERVICE-DISCOUNTS. Fertilizer discounts help in the fall. Many companies provide extra services, such as soil sampling and testing, and may have other benefits to encourage fall purchase.

It is generally cheaper to store fertilizer in the soil than in a warehouse. There can also be a tax advantage to the farmer.

ANY LOSSES? On most Midwest soils, plowed down P and K stays put. But we hear much comment on possible losses that may occur with fall applied nitrogen.

Agronomists generally agree that nitrogen is most effective when sidedressed a few days to six weeks after planting, if you can get it on—second best just before planting; third, early spring; fourth, late fall. But the differences are usually very small except on sand.

You should delay fall application of ammonia until soil temperature at 4 inches is down to 50° or less. Nitrification proceeds only half as rapidly at 50° as at 60° and only one-tenth as rapidly at 40°. It essentially stops at 30°. Of course, rainfall decreases as we go west and the 50° rule becomes less important.

Leaching of fall and early spring applied nitrogen is not considered important on silt loams and clay loams, particularly in the western Corn Belt. Some of the nitrates may move as deep as 4 to 5 feet, but corn roots effectively feed to this depth in many soils. In fact, having nitrates at this depth may be an advantage during a drought.

Nitrates on dry surface soil are unavailable. Fall application of nitrogen cannot be encouraged on sandy soils.

HOW MUCH FERTILIZER? Obviously if only a small amount of fertilizer is used,
TO UREVIG—PAGE 28

ELLER—FROM PAGE 27

now plant for a final stand of 23-24,000 plants.

HIGH FERTILIZER RATES. During November and December, the second fertilizer application is made as a liquid application in bands on each side of the row—flat land applications at right angles to the direction seed will be drilled. This application, mostly nitrogen, is designed to bring the total fertilizer application up to the final rate for the year with no side-dress application.

With a rate of 140-80-70 on 1215 acres of dryland milo (14% moisture), the 1967 yield was 5819 pounds per acre. On 365 acres of the total, where a trial rate of 150-100-75 was used, the yield was 7549 pounds per acre (14% moisture). Needless to say, we used 150-100-75 rates on all 1300 acres of sorghum planted in 1968.

Corn was fertilized in 1967 with a rate of 200-100-72 on most of the 925 acres. Half of it was irrigated. The average yield was 116 bushels per acre (15% moisture). But on a trial 140-acre field of irrigated corn fertilized with 250-150-100, the yield reached 150 bushels per acre.

The yield of several dryland fields receiving this rate increased so much that we used a 250-150-100 rate for all 1000 acres in 1968.

K AIDS STANDABILITY. Soil tests show most of the Miller and Norwood clay and silty-clay soils of this area very high in potassium. But experience has shown added potash maintains good standability.

UREVIG—FROM PAGE 27

it may be applied in spring as a starter. But progressive farmers make use of all the technology available. And part of the technology having great impact today is high fertilization.

What is meant by high fertilizer levels? Look at FIGURE 1. Corn Belt usage in

Samples taken in July, 1967 show K_2O soil level to range from 400 to 1000 pounds per acre, depending on soil type and previous cropping.

With high N and P rates, perhaps the soil K does not become available as rapidly as plants need it. Liberal potassium rates are used on Chance Farm grain for better standability and earlier maturity.

PLANT EARLY, with no cultivation. Early planting is a must for high grain yields in almost any area. With the higher fertility rates the "full season" varieties have proven to yield best here. But with a "full dose" of fertility, these varieties usually mature along with so-called early maturing varieties.

Corn is planted here in late February and early March. Sorghum planting begins after corn planting and hopefully is completed about March 15.

Immediately following planting and before the plants come up, an aerial broadcast herbicide application is made to all grain acreage.

This is it—no cultivation, no side-dress applications—we are through with the crops until harvest. The next trip through the fields is with combines that handle both crops by only changing headers.

Last year sorghum netted more dollars per acre than corn. The year before corn was ahead. In 1968—who knows?

We on the Chance Farm only know that even with all the progress we have made in grain production, we still have a long way to go. **We all must continue to progress in both yield and efficiency to beat the price-cost squeeze—to keep our heads above water in our present economy with its rapidly rising production costs.**

THE END

1967 was about where we were on Tilney Farms in about 1960. In 1967 we used double the Corn Belt average. Our use has increased dramatically since 1965. If we project Tilney Farms use at the increased rate since 1960, we will use **400 lbs. of nutrients per acre by 1970.**

USE-YIELD RELATION. We have

found a strong correlation between the amount of plant food applied and yield response.

Our records and yields are averaged over several thousand acres and lend credence to results. **In 1967 corn yields were over 60 bu. greater where the fertilizer rates were 75 percent greater.**

WHAT IS HIGH FERTILITY? We wish we knew. By averaging and grouping P and K soil test levels for many fields and averaging soybean yields, we think some trends are apparent in FIGURE 2.

The bars in the graph are the average soil K value found. Note the pattern of yield increase as the fertility increased based on the P and K soil tests.

A P soil test of 20 to 30 has been considered high. According to the graph, should we be striving for a level of 80-100 P and 500 K or higher? What levels should we strive for on the fine textured tight soils? If we go to the higher levels, what problems will we create? Will zinc become a problem?

Regardless of the problems, fall fertilization will play a big role in achieving high soil test levels.

KEEP ON TESTING. Because of changing inputs—such as new varieties, fertilizer combinations, effects of high levels of fertility, micronutrient response, and many other variables—we carry on a field testing program. The trials include corn, soybeans, and sugar beets. We expect to include sweet corn for 1968.

We use four 12-acre fields entirely for trials. We test 26 corn hybrids each year. Though we supposedly select the best hybrids from each company, we find yields differing 30 or more bushels among them.

We feel the testing program is essential in helping us determine: (1) **what better corn varieties to select**, (2) **how high we should go on N, P and K**, (3) **effect of residual fertilizer on successive crops**, (4) **the influence on crop yields and quality**, (5) **micronutrient response on high fertility plots.**

We need more specific information with the higher inputs we are using. We need

TRENDS IN FERTILIZER USE PER TILLABLE ACRE

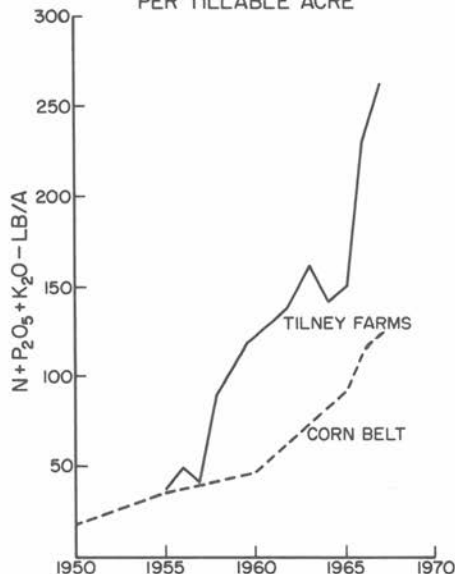


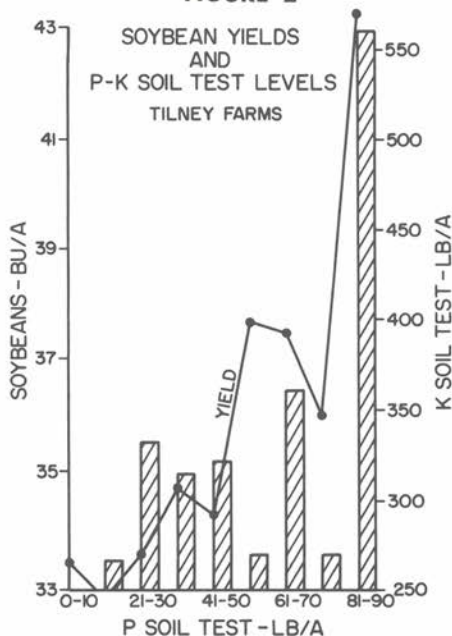
FIGURE 1

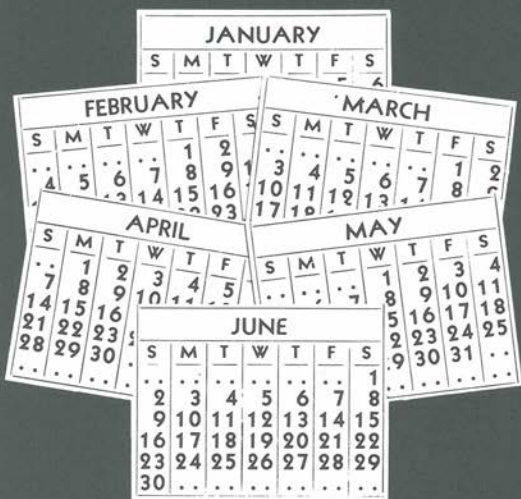
to know yield and quality effects and what the long term effects may be on soils and their wise use.

Besides knowing university research, each farmer should do some testing of his own, especially with corn varieties and simple fertilizer rates and combinations. **You can check out fall or winter fertilization on your own farm. We have done it and are pleased with the results.**

THE END

FIGURE 2





Profit Pointers To Ponder



IT PAYS TO KNOW . . .

THAT ideal days for planting cotton in the South total less than a week.

You can be ready for that busy week by getting the bulk of your fertilizing out of the way in fall and winter.

THAT a grower can eat up 17.5% of his time opening and carrying bags and filling hoppers to apply 500 lbs. of fertilizer through his planter.

And he will still not supply full needs for today's high-yield demands. More and more fertilizer is being broadcast and plowed down ahead of planting to build soil fertility.

THAT phosphorus fixation can be eliminated on acid soils with liming and on all soils by building a high soil P level.

Soil receiving 50 lbs. P_2O_5 each year for 7 years produced 29 bushels per acre MORE corn than soil receiving only one application one year, North Carolina research found.

THAT potassium moves little in heavy textured soils and during winter.

Tennessee research found most of it still in the top six inches even after 4 annual treatments, while Florida found only 6.5% of a 240-lb. K_2O application moving below 24" in a fine sand soil during winter. And this was under fallow with 29 inches of winter rainfall.

THAT fall applied nitrogen for spring crops is GO everywhere except Southeast United States and on sandy soils.

And some upper South soils get cold enough (50°F or below) to allow efficient fall-winter nitrogen use. Virginia found no yield difference in fall, winter, or spring applications on heavy-textured soils.



IT PAYS TO KNOW . . .

THAT most sandy surface soils have clay subsoils that can hold potassium for later root-feeding action.

South Carolina research found 460 lbs. K_2O per acre accumulating in the subsoil of a Norfolk fine sandy loam. This K is ready to feed plant roots unless a hardpan or highly acid soil layer hovers at plow-sole depth.

THAT heavy residues—cornstalk, small grain, forage stubble—reduce losses.

Cornstalk residues, for example, are much heavier today than even 3 years ago. And fallow or plowed soils tend to allow more movement into the soil than sod cover. An 8% Vermont slope lost only 3 lbs. N, 1 lb. P from 10-ton winter manure.

THAT fertilizer “melts” through snow just as salt melts through ice.

Light winter snow doesn't stop top growers. They put 4 tons in a 4-ton spreader on solid winter ground, while soft spring may slow them to 2 tons per 4-ton spreader. So, they spread on level winter soils, on short slopes up to 10% with heavy residues, on long slopes (over 200 ft.) up to 8% with heavy residues, on rough surface conditions that retard runoff, on slopes up to 4% with thin residue cover.

THAT broadcast potassium moves much less in soils than banded potassium.

North Carolina research found banded K fertilizer leached six times more than broadcast potassium on a fine sandy loam. Broadcasting potassium reduces its concentration in any one soil zone. This reduces leaching chances. Fall-winter applications are a natural for broadcast.



IT PAYS TO KNOW . . .

THAT plowdown fertilizer often gives better yields than disked nutrients—sometimes 10 MORE bushels per acre corn.

It puts time to best use, with fertilizer spreaders and plows following right behind soybean and corn combines. It puts the plant food deep to give crops extra feeding and a cushion between rains next summer. Iowa research found both plowdown phosphorus and potassium boosted corn yields 8 bushels PER ACRE over the disked-in method.

THAT deeper plowing requires more fertilizer and lime to enrich the greater plow layer it creates.

When a good grower gradually plows from 6 to 11 inches deep, he increases his nutrient rate about 50%. He does this because the extra soil dilutes his former applications in the plow layer . . . because the newly turned soil may be nutrient poor.

THAT plowdown can save a trip when fall N is applied with the plow.

In eastern U.S., it can be done when soil reaches 50°F four inches deep . . . in western Corn Belt anytime in fall since temperature and leaching are no problem with low fall-winter rainfall. But don't apply fall N on coarse textured or sandy soils.

THAT fall-winter fertility starts a chain reaction toward top-profit yields.

Earlier planting leads to earlier harvesting of more mature corn, less field loss. Illinois found early planting can pay 10 to 20 bushels per acre EXTRA. Each day a Corn Belt grower delays planting after the first week in May can cost him one to two bushels per acre. Minnesota found earlier planted



IT PAYS TO KNOW . . .

corn means earlier planted soybeans with higher yields—nearly 5 bu. per acre bonus.

THAT a grower can earn \$400 to \$1200 MORE per planting day, depending on the acres of corn and the time he plants.

May weather usually gives 13 to 15 planting days. Minnesota found a grower may gain \$425 MORE per planting day the **first half** than the **last half** of May on 200 acres, \$1273 on 600 acres.

THAT fall-winter fertility makes the grower more flexible and the industry more service-sure.

For the grower it speeds planting . . . reduces spring work load, soil compaction, costly delays . . . beats late spring drouth in the South, gets on full feed fertilizer.

For the industry it increases plant volume . . . improves customer service and equipment use . . . spreads work load . . . reduces storage needs and demurrage.

THAT special flotation tires can help stretch a busy grower's season.

They save his time. They save his soil tilth. They allow spreading more days in a wet fall, winter, or spring on marginal soils.

THAT heavy fall feeding helps insure high-value forages and turf grasses against winter injury.

Fall fertility lowers freezing point of plant cell sap, insures stronger roots, and reduces respiration and water loss. In a severe Midwest winter, 90% of poorly fertilized alfalfa died, only 20% of the well fertilized crop. Some



IT PAYS TO KNOW . . .

specialists now say frequently cut alfalfa might well contain 3 to 4% potassium rather than the traditional 2% to insure high yields and winter-live.

THAT the number of days a grower can spread on frozen ground depends on his location.

Indiana found the time increased from south to north, probably representative of much of the Midwest. Southern region: 30-40 days; Central region: 55-65 days; Northern region, 70-80 days.

THAT the grower has time to wait for decent weather in fall.

Illinois harvests 84% of its soybeans by October 20, 79% of its corn by November 10, leaving many days to fertilize and plowdown before snow gets deep. Spring rush does not give such time.

THAT fall plowing insures warmer soil quicker next spring.

Frost can leave a dark, sun-absorbing plowed soil 10 days ahead of an unplowed field insulated by light-colored crop residues.

THAT fall plowing helps reduce insect problems next spring.

Plowed fields expose larvae to wind, snow, and ice, reducing survivors. Fall plowed fields showed 45% less western and northern corn rootworm larvae than spring plowed soils in Midwest tests.

THAT storing NPK in fall-winter soils is an insurance policy.

Against spring delays: not enough vehicles to deliver demands, enough right analyses, enough labor, enough days to do the job. **THE END**

FALL-WINTER FERTILIZER CAMPAIGN AIDS

(Order samples and quantities here)

Free Sample Quantity

NEWSLETTERS:

M-150-68 (Practice Flexible Fertility) for North

3¢ Ea.

S-155-68 (Practice Flexible Fertility) for South

3¢ Ea.

Wall Chart: Facts Favor Fall-Winter Fertilization

10¢ Ea.

FOLDERS:

Beat the Weather—I-7-65

3¢ Ea.

Face Fall-Winter Facts—C-Su-66

"

Place Mats for Dinner Meetings:

200-bushel Corn

2¢ Ea.

Year-Round Fertilization

"

80-Bushel Soybeans

"

Grow Healthy Turf

"

Grow 10-Ton Alfalfa

"

Newspaper Advertising

Mats:

Fertilize In Fall To Prevent Spring Stall

15¢ Ea.

Growers In The Know Go In The Snow

"

Don't Sink Dollars In The Mud

"

Build Your Soil For Year-Round Toil

"

Promotion Pictures Kit

Full Color Postcard

2¢ Ea.

Newspaper Want Ads &

Radio Ad Spots Kit

15¢ Ea.

Fall-Winter Fertilizer Slide Set & Script Purchase, \$6.25

10-Day Loan

Total payment \$

Send me a free file copy of this issue of **BETTER CROPS** Magazine to replace this one from which we are clipping and ordering fall-winter educational aids. YES

NAME

ADDRESS

CITY

STATE

ZIP CODE

ORGANIZATION

American Potash Institute, 1649 Tullie Circle, N.E., Atlanta, Georgia 30329

Cut along this line

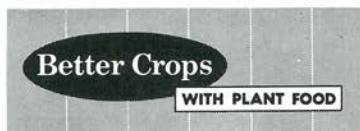
Spread Flexible Fertility Idea

YEAR-ROUND THROUGH . . .

NEWSLETTERS, FOLDERS, WALL CHARTS,
PLACE MATS, MAILER CARDS, ADVERTISING
MATS, NEWSPAPER-RADIO AD SPOTS,
SLIDE SETS.

**ORDER FROM INSIDE
THIS COVER**

**AMERICAN POTASH INSTITUTE
1649 TULLIE CIRCLE, N.E.
ATLANTA, GEORGIA 30329
PHONE 404-634-4274**



Controlled circulation postage
paid at Washington, D. C.

AMERICAN POTASH INSTITUTE, INC.
1649 Tullie Circle, N.E., Atlanta, Ga. 30329

THE POCKET BOOK OF AGRICULTURE
