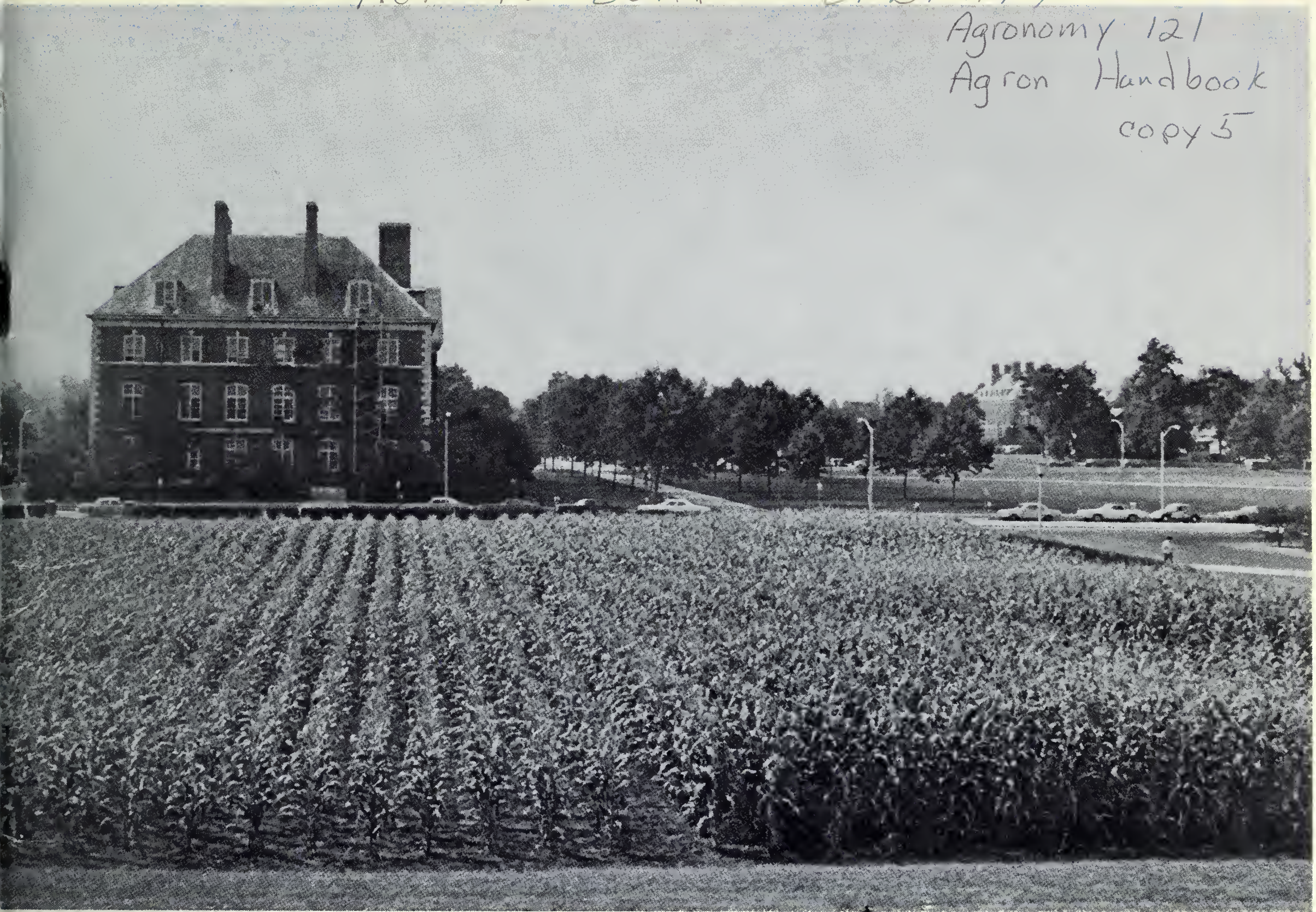
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN/COLLEGE OF AGRICULTURE/COOPERATIVE EXTENSION SERVICE/CIRCULAR 1115





# ILLINOIS AGRONOMY HANDBOOK 1976

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# CORN

## Planting Date

Plant early if possible. Yields will be higher on the average. In addition the plants will be smaller, ears lower, and more uniform in height.

Start anytime after April 1 in southern Illinois, April 10 to 15 in central Illinois, and April 20 to 25 in northern Illinois. In central and northern Illinois the corn planted in April may yield no more than that planted during the first few days of May. However, starting in April improves your chance of finishing in early May.

The temperature of the soil may be used to help you decide whether to start planting in April — don't worry about soil temperature after May 1.

Table 1. — Effect of Planting Date on Yield

| | Northern Illinois[a] | Central Illinois[b] | Southern Illinois[c] |
|---|---|---|---|
| | *Bushels per acre* | | |
| Late April | 170 | ... | 102 |
| Early May | 175 | 142 | 105 |
| Mid May | 168 | 134 | 82 |
| Late May | 154 | 126 | ... |
| June 1 | ... | ... | 58 |

[a] 3-year average at Northern Illinois Research Center.
[b] 2-year average at Urbana.
[c] 3-year average at Carbondale.

Here are two useful guides, though they may not be correct all the time.

1. Plant when the temperature at *7:00 a.m. reaches 50° F. at the 2-inch level.* This will assure a temperature favorable for growth during most of a 24-hour period if there is an appreciable amount of sunshine.

2. Plant when the temperature at *1:00 p.m. reaches 55° F. at the 4-inch level.* The 4-inch level is suggested for the 1:00 p.m. measurement because this level is not affected as much as the 2-inch level by a single day of bright sunshine. After the first of May, *plant if the soil is dry enough even though temperature is below* the suggested guidelines. Perhaps a simple way to say it is: early in the season plant according to soil temperature; later on plant by the calendar.

Incidentally, soil temperature data put out by the weather bureau are taken under sod where the midday temperature at 2 to 4 inches is often 8 to 12 degrees lower than under bare ground.

## Extra Early Corn Planting When Soil and Weather Conditions Permit

It is a reasonable goal to plant 25 percent of your corn acreage two weeks before and 10 percent three weeks before the normal planting date for your area when a good seedbed can be prepared and soil temperature is favorable. The ideal would, of course, be to select the optimum date based upon long-term research tests and to plant the entire acreage on that date. Unfortunately, that is not how the real world operates. Here then are six reasons for extra early planting.

1. When you intentionally delay planting after soil conditions are right you have lost control of your date of planting in that year. Wet weather may set in and keep you out of the field far beyond the optimum date. Or the opposite may occur — the seedbed may dry so seed will not germinate. Early planted fields would have sprouted and become established before the seedbed dried out. That happened in the case of soybeans in some areas in 1972.

2. The optimum date to plant is slightly earlier than *is indicated by published date-of-planting studies* because there was no plant population variable included in the research studies. Since extra early planting allows a few additional thousands of plants per acre, farmers can capitalize on this and often harvest a greater yield advantage for earlier planting than is indicated in the research trials.

3. The average yield reduction from planting ten days too early is less than from planting ten days too late.

4. Having some extra early planted corn spreads the risk of unfavorable weather at the critical silking time which interferes with kernel set.

5. The earlier that corn is ready for harvesting in the fall, the better the chances of field drying and of avoiding field losses from bad weather and excessive stalk breakage.

6. There is often a slight price advantage for early harvested corn in the fall.

The hazards of early planting include: a) poor stand because of a cold, wet soil; b) weed problems in case the soil is too wet for timely cultivation; and c) frost injury. Frost effect is undoubtedly grossly exaggerated in the minds of most farmers. The weed problem can be largely offset by the proper choice of preemergence herbicide. The hazard of poor stand from cold, wet soil is real, but is far less of a danger than 30 years ago because of modern seed treatment. Furthermore, in the unlikely event of very poor growing conditions, an inadequate stand can be corrected by replanting for the cost of seed plus the planting operation itself.

We are not aware of any case of loss of stand by frost as the result of too early planting in Illinois during the past 15 years. Substantial acreages of corn were frosted in 1963, 1965, and 1972. The dates of frost ranged from May 30 to June 21. Corn planted at normal dates was as vulnerable as the extra early planted fields. Loss of stand occurred only when there was an extended period of poor growing weather after the frost.

The reason why frost effect is usually small is that it kills only a few leaves on the young corn plants. These leaves, though the upper ones at the time of frost, would have soon become the lower leaves on fully grown plants and were destined to soon become ineffective because of being shaded by leaves further up the stalk when the plant reached full height. Most of them in fact break off before the plant is full grown. The growing point of corn is seldom killed by freezing because it is below ground level until the plant is about knee high.

Researchers at the Michigan Agricultural Experiment Station planted corn about April 15 for at least 14 consecutive years. The corn was often frosted once and sometimes twice with little effect on yield.

## Degree Days and Corn Development

Temperature records can be used to predict the maturity development of corn. The greater the amount of solar energy received, the more rapid the development of corn toward maturity. Corn hybrids of differing maturities require differing amounts of solar energy to reach maturity.

The "degree day" is used to describe and record the solar energy received.

The hybrid seed corn industry has generally adopted "Growing Degree Days" (GDD) as a maturity rating system for hybrids. The GDD for an individual day (24 hours) is calculated in the following way.

$$\frac{\text{Maximum daily temperature} + \text{Minimum daily temperature}}{2} - 50 = \text{growing degree days}$$

Since corn grows little, if at all, at temperatures lower than 50° F., this temperature is substituted for the actual minimum whenever the daily minimum drops below 50° F. Eighty-six degrees is substituted for the maximum whenever the daily maximum exceeds 86° F. Therefore, 50° F. is the lower cutoff temperature and 86° F. the upper cutoff temperature.

The starting point for keeping a record of the accumulated GDD normally is time of planting. It ends when physiological maturity is reached. A kernel moisture content of about 30 percent is an indicator of maturity.

Corn grain is physiologically mature when dry matter is no longer being deposited in the kernel. At this point the kernel has reached its greatest dry weight and maximum yield has been obtained. The moisture content of the kernel is in the neighborhood of 30 percent. Some hybrids will carry a little more and some a little less than 30 percent moisture.

At this stage of maturity the embryo may be injured by very low temperatures and germination may be reduced, but neither the commercial value nor the feeding quality of the grain is damaged. Therefore, corn is considered safe from frost when it reaches physiological maturity.

The moisture content has been used for many years as an indicator of maturity. While it is a good measure, you must have access to a moisture meter. This often means taking a sample of grain to the local elevator or seed house.

Another measure of maturity is the black layer which develops near the tip of the kernel. As maturity is reached several layers of cells near the tip of the kernel shrink and compress into a dense layer that appears black to the naked eye. This shrinking and compression closes off the conducting tissue that links the kernel to the cob. Translocation and the accumulation of dry matter in the kernel ceases. The kernel is mature.

The black layer appears first in the small kernels at the tip of the ear and last in the large kernels at the butt of the ear. The moisture content present when the black layer is formed will vary among hybrids. Full-season hybrids and late-planted corn tend to develop the black layer at a higher moisture level than do early hybrids and early planted corn.

To use the black layer as an indicator of maturity and grain moisture content, split the kernels lengthwise with a sharp knife. The layer of cells that form the black layer will turn brown first and then black. Be sure to check the freshly harvested ear because the black layer will form as prematurely harvested kernels dry.

You can consider corn mature when at least 75 percent of the kernels in the middle of the ear have formed black layers or when 75 percent of the ears examined have formed black layers. The black layer is probably a better indicator of maturity than of moisture content. A reliable moisture test remains the best means of determining moisture content.

## Planting Rate

The optimum planting rate might be defined as the one that will result in the maximum population that can be supported with normal rainfall and distribution without excessive barren plants or pollination problems. This population will be slightly more than optimum in years

**Table 2. — Effect of Crowding on Corn, Urbana, Illinois**

| Variety | Plants per acre planted in 30-inch rows | | |
|---|---|---|---|
| | 16,000 | 24,000 | 32,000 |
| | *Bushels per acre* | | |
| A | 127 | 140 | 153 |
| B | 126 | 98 | 62 |

Table 3. — Effect of Nitrogen and Plant Population on Corn Yields, Northern Illinois Experiment Field

| Nitrogen | Plants per acre | | |
|---|---|---|---|
| | 16,000 | 22,000 | 28,000 |
| *Pounds per acre* | | *Bushels per acre* | |
| 0 | 88 | 83 | 76 |
| 240 | 139 | 148 | 158 |

Table 4. — Effect of Row Width on Corn Yield, Urbana, Illinois

| Plants per acre | Row width | |
|---|---|---|
| | 40 inches | 30 inches |
| | *Bushels per acre* | |
| 16,000 | 127 | 132 |
| 24,000 | 133 | 144 |
| 32,000 | 126 | 138 |

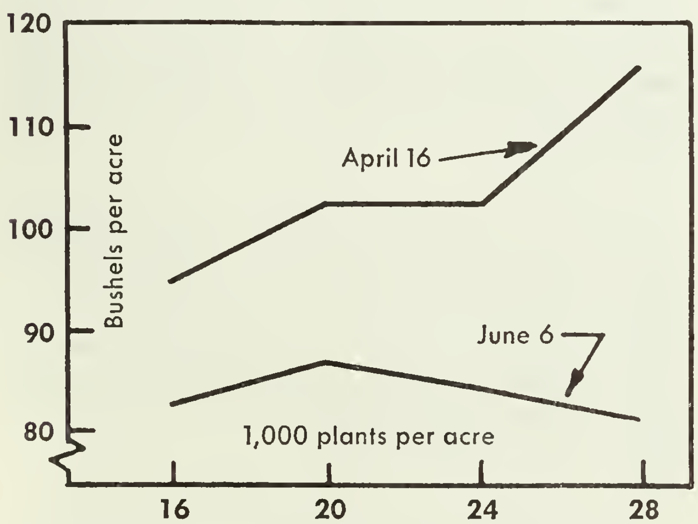
with less than normal rainfall and probably less than optimum in years of higher but not excessive rainfall.

Many facts must be known before determining the optimum population for a particular field. These include:

1. **The crowding tolerance of the variety.** Varieties differ in their ability to tolerate high populations (Table 2).

2. **The fertility level, especially nitrogen.** Increase the amount of nitrogen applied as population increases (Table 3).

3. **Row width used.** Population can usually be increased 2,000 to 4,000 plants per acre when rows are narrowed from 40 inches to 30 or 20 inches without any serious increase in barrenness or pollination problems. The result is an increase in yield (Table 4).




**Planting date and population, Dixon Springs. (Fig. 1)**

4. **Planting date.** Varieties that tolerate high plant populations may be planted at a higher population when planted early than when planted late (Fig. 1). There are several reasons for this. First, the early planted corn is shorter. Second, the early planted corn is more likely to pollinate during a period with favorable rainfall and temperature. Third, less of the subsoil moisture reserve has been used up. Moisture stress during the pollinating period is aggravated by high population.

In summary, a specific recommendation on planting rate is impossible unless such facts as the soil type, fertility level, date of planting, and so on, are known. If you are changing varieties or making a major change in some other practice, increase the population by 2,000 to 4,000 plants per acre over that which you normally use. Do this in two or three places in the field and check the effect of the increase in the fall.

## High-Lysine Corn

Lysine is one of the amino acids essential to animal life. Ruminants need not be concerned whether the protein they eat contains this amino acid because the microflora in their rumen can synthesize lysine from lysine-deficient protein. Non-ruminants cannot do this, so swine, poultry, and humans must have a source of protein that contains sufficient lysine to meet their needs.

Normal dent corn is deficient in lysine. The discovery in 1964 that the level of this essential amino acid was controlled genetically and could be increased by incorporating a gene named Opaque 2 was exciting news to the corn geneticist and the animal nutritionist.

The potential value of this discovery to the swine farmer was obvious when feeding trials demonstrated that growing swine needed very little additional protein when fed high-lysine corn.

Agronomic research work with high-lysine corn indicates that it is slightly lower in yield and higher in moisture than its normal counterpart. It also has a softer kernel which sometimes contributes to stand loss under adverse weather conditions.

Current research with more sophisticated hybrids indicates that the differentials in yield may be overcome. Continued work will probably solve the other problems in the future.

Swine growers should explore the possibility of growing high-lysine corn.

The Opaque 2 gene is a recessive gene. This makes it vulnerable to contamination by pollen from normal dent corn. Therefore, high-lysine corn should not be planted in fields where normal dent corn is likely to volunteer and the outside rows along the sides and ends of the field may need to be harvested and segregated from the remainder of the field. Lysine content may be reported as percent of dry weight or on a No. 2 yellow corn basis. Since No. 2 yellow corn may contain up to 15.5 percent moisture, the lysine content will be slightly lower than when expressed as percent of dry matter.

With the aid of agricultural extension advisers, 136 high-lysine samples were obtained from 35 counties during the 1973-74 winter. The percent lysine and percent total protein were determined for each sample as well as the percent of contamination from normal corn. The samples ranged from a low of 0.29 percent to a high of 0.54 percent. The average of all 136 samples was 0.37 percent. Seventy-seven percent of the variation in percent of lysine could be accounted for by variation in total protein and contamination from normal corn. The sample with the lowest lysine content also had the lowest protein content (7.3 percent). The sample with the highest lysine content had the highest protein content (12.2 percent). The lysine and protein contents are on a dry matter basis. To convert to a No. 2 corn basis (15.5 percent) multiply by 0.845.

**Liguleless or upright-leaved corn** development and research indicates these types are more tolerant of high populations. One form of the upright leaf angle is controlled by a gene known as liguleless. Upright leaves in the upper part of the corn plant allow more light to penetrate deeper into the leaf canopy, providing more solar energy for leaves in the lower half of the plant at the earshoot level.

Illinois researchers have shown that as the corn leaf becomes more upright the amount of photosynthesis done by a given area of a leaf is slightly less. However, the upright leaves allow more light to penetrate into the canopy and enable the lower leaves to conduct photosynthesis at a greater rate than under heavily shaded conditions. Better distribution of light energy over the plant should return a higher yield.

**High-oil corn.** In the summer of 1896, Dr. C. G. Hopkins started breeding corn for high oil content. With the exception of three years during World War II, this has been a continuing research at the University of Illinois. The oil content of the material that has been under continuous selection has been increased to 17.5 percent as compared with 4 to 5 percent which is normal for dent corn.

Until recently efforts to develop varieties that were materially higher in oil than normal dent corn resulted in disappointing yield performance. Recent research results, which involve new gene pools of high-oil material unrelated to the original Illinois High Oil, indicate that varieties which contain 7 to 8 percent oil may be produced with little or no sacrifice in yield.

Commercial high-oil varieties are available. The question of yield as compared with normal corn will be determined in the field. However, there will probably be little difference.

Since oil is higher in energy per pound than starch, a ration containing high-oil corn should have some advantage over one containing normal corn. Feeding trials involving high-oil corn generally confirmed this assumption.

The corn-milling industry interest in high-oil corn as a source of edible oil is increasing. Corn oil has a high ratio of polyunsaturated fatty acids to saturated fatty acids and it is used in salad oils, margarine and cooking oils.

**Waxy maize.** Waxy maize is a type of corn that contains 100 percent amylopectin starch instead of 75 percent which is normal for dent corn. Amylopectin starch is used in numerous food and industrial products.

Our chief source of supply of amylopectin starch prior to World War II was tapioca which was imported from eastern Asia. The Japanese occupation of what was then known as the Dutch East Indies essentially cut off our supply of tapioca and an emergency program to develop and produce waxy maize was undertaken by the government.

After the war, waxy maize continued to be an important supply of amylopectin starch. Several corn milling companies annually contracted for its production in the central Corn Belt.

The results of recent feeding trials at the University of Illinois indicate that the value of waxy maize as a livestock feed may have been overlooked.

These trials, which involved lambs and yearling steers, showed that animals fed waxy maize gained faster and more efficiently than those fed normal corn.

The waxy characteristic is controlled by a recessive gene. Therefore, waxy corn pollinated by pollen from normal corn will develop into normal dent corn. Waxy corn, like high-lysine corn, should not be planted in fields where dent corn is likely to volunteer and the outside 6 to 10 rows or equivalent may need to be kept segregated from the remainder of the field to keep the amount of contamination from normal corn to an acceptable level.

**High-amylose corn.** High-amylose corn is corn in which the amylose starch content has been increased more than 50 percent. Normal corn contains 25 percent amylose starch and 75 percent amylopectin starch.

The amylose starch content is controlled by a recessive gene. Therefore isolation of production fields is important, as is selecting production fields that were not in normal corn the previous year.

# SOYBEANS

## Planting Date

Soybeans should be planted in May. The full-season varieties will yield best when planted in early May. Earlier varieties often yield more when planted in late May than in early May. The loss in yield of the full-season varieties when planting is delayed until late May is minor as compared with the penalty for planting corn late. Therefore, the practice of planting soybeans after the corn acreage has been planted is an accepted and wise practice.

The loss in yield of soybeans becomes more severe when planting is delayed past early June. However, the penalty for late-planted corn is proportionally greater and the danger of wet or soft corn becomes such a threat that soybeans are, under many conditions, a better crop for late planting than corn (Tables 5 and 6).

**Table 5. — Yields of Soybeans Planted on Four Dates, Urbana**

| Variety | Date of planting | | | |
|---|---|---|---|---|
| | May 7 | May 21 | June 8 | June 19 |
| | *Bushels per acre* | | | |
| Corsoy | 56 | 62 | 49 | 42 |
| Beeson | 57 | 55 | 52 | 47 |
| Calland | 56 | 51 | 47 | 40 |

**Table 6. — Yields of Soybeans Planted on Four Dates, Carbondale**

| Variety | May 3 | May 17 | June 7 | July 1 |
|---|---|---|---|---|
| Corsoy | 27 | 38 | 43 | 28 |
| Cutler | 62 | 46 | 54 | 27 |
| Dare | 72 | 45 | 37 | 32 |

**Effect on maturity.** The vegetative stage (planting to the beginning of flowering) is 45 to 60 days long when full-season varieties are planted at the normal time. This period shortens as planting is delayed and may be only 25 to 26 days long when these varieties are planted in late June or early July (Tables 7 and 8).

Soybeans are photoperiod responsive and the length of the night or dark period is the main factor in determining the beginning of flowering. The vegetative period is also influenced by temperatures — high temperatures shorten and low temperatures lengthen it — but the main effect remains that of the length of the dark period.

The length of the flowering period and that of pod filling are also shortened as planting is delayed. However, the effect of time of planting on these periods is minor when compared to that of the vegetative period.

**Table 7. — Days to Maturity for Three Planting Dates, Columbia, Missouri (Six-Year Average)**

| Variety | May 1 | June 1 | June 12 |
|---|---|---|---|
| Hawkeye | 122 | 104 | 98 |
| Clark | 149 | 115 | 105 |

**Table 8. — Days to Maturity for Four Planting Dates, Carbondale**

| Variety | May 3 | May 17 | June 7 | July 1 |
|---|---|---|---|---|
| Corsoy | 118 | 103 | 107 | 101 |
| Wayne | 131 | 117 | 117 | 105 |
| Cutler | 145 | 133 | 117 | 108 |
| Dare | 159 | 153 | 138 | 122 |

## Planting Rate

A planting rate that results in 10 to 12 plants per foot of row at harvest in 40-inch rows, 6 to 8 plants in 30-inch rows, 4 to 6 plants in 20-inch rows, or 3 to 4 plants in 10-inch rows will provide maximum yield for May and very early June planting. Higher populations usually result in excessive lodging. Smaller populations often yield less, and the plants branch more and pod lower. This contributes to greater harvesting loss.

Populations should be increased by 50 to 100 percent for late June or early July plantings.

## Row Width

If weeds are controlled, soybeans will yield more in narrow rows than in the traditional 38 to 40-inch rows (Table 9).

**Table 9. — Soybean Yields for Row Spacings of 10, 20, 30, and 40 Inches, Urbana**

| Variety | 40 inches | 30 inches | 20 inches | 10 inches |
|---|---|---|---|---|
| | *Bushels per acre* | | | |
| Wayne | 47.0 | 51.2 | 52.4 | 53.6 |
| Harosoy | 38.8 | 42.0 | 45.0 | 48.0 |

**Table 10. — The Yield of Double-Cropped Soybeans When Planted in 20- and 30-inch Rows in 1972**

| | 20-inch rows | 30-inch rows |
|---|---|---|
| | *Bushels per acre* | |
| Dixon Springs | 53 | 43 |
| Brownstown | 37 | 32 |
| Urbana | 33 | 24 |

Since late-planted soybeans are normally not as tall as those planted in early May, the advantage for using narrow rows increases as planting is delayed past early June. Soybeans planted after the small-grain harvest should be planted in rows at least as narrow as 30 inches and 20-inch rows are better (Table 10).

## When To Replant

An experiment at Urbana in 1969 demonstrates the ability of soybeans to compensate for loss of stand. The soybeans were planted in 30-inch rows and thinned when in the second-leaf stage to stands of 50, 66, and 80 percent of the original stand of six plants per foot of row. Plots were 20 feet long and the reductions in stand were accomplished by a uniform removal of plants and by removing all plants for specified distances in the row. For instance, three gaps of 40 inches in 20 feet of row equals 50 percent of the original stand. The results of this experiment shown in Table 11 may be valuable when the question of whether to replant must be answered.

**Table 11. — The Ability of Soybeans to Compensate for Loss of Stand, Urbana**

| Treatment | Percent of original stand | Yield (bu./A.) |
|---|---|---|
| Six plants per ft. of row | 100 | 50 |
| Three plants per ft. of row | 50 | 50 |
| Three 40-inch gaps | 50 | 41 |
| Five 24-inch gaps | 50 | 44 |
| Four plants per ft. of row | 66 | 51 |
| Two 40-inch gaps | 66 | 43 |
| Five 16-inch gaps | 66 | 47 |
| Five plants per ft. of row | 80 | 50 |
| Two 24-inch gaps | 80 | 47 |
| Five 9.6-inch gaps | 80 | 47 |

## Double Cropping

See Cooperative Extension Circular 1106, "Double Cropping in Illinois."

## Seed Source

To insure growing a good crop you must do a good job of selecting seed. When evaluating seed quality, consider the percent germination, percent pure seed, percent inert matter, percent weed seed, and the presence of disease and damaged kernels.

Samples of soybean seed taken from the planter box as farmers were planting showed that home-grown seed was inferior to seed from other sources (Tables 12 and 13). The germination and pure seed content of home-grown seeds were lower. Weed seed content, inert material (hulls, straw, dirt, and stones), and other crop seeds (particularly corn) in home-grown seed were higher.

Farmers who purchased certified seed obtained a higher quality seed on the average than farmers purchasing uncertified seed.

**Table 12. — Uncertified Soybean Seed Analysis by Seed Source**

| | Germination | Pure seed | Weed seed | Inert matter | Other crops |
|---|---|---|---|---|---|
| | *Percentages* | | | | |
| Home grown | 79.6 | 95.5 | .02 | 2.29 | 2.27 |
| Neighbor grown | 80.8 | 97.5 | .01 | 2.06 | .41 |
| Seed dealer | 81.2 | 97.8 | .001 | 1.48 | .77 |

**Table 13. — Certified and Uncertified Soybean Seed Analysis**

| | Samples | Germination | Pure seed | Weed seed | Inert matter | Other crops |
|---|---|---|---|---|---|---|
| | | *Percentages* | | | | |
| Uncertified | 363 | 80.2 | 95.5 | .02 | 2.6 | 2.0 |
| Certified | 56 | 84.2 | 98.7 | .001 | 1.2 | .2 |

This evidence indicates the Illinois farmer could improve the potential of his soybean production by using higher quality seed. The home-grown seed is the basic problem. Few farmers are equipped to carefully harvest, dry, store, and clean seeds, and to perform laboratory tests adequately to assure themselves of high-quality seed. Agriculture today is a professional enterprise. If a farmer is not a professional seed producer and processor, he may be well advised to market his soybeans and obtain high-quality seed from a reputable professional seedsman.

The state seed tag is attached to each legal sale from a seed dealer. Read the analysis and consider if the seed being purchased has the desired germination, purity of seed, and freedom from weeds, inert material, and other crop seeds. The certified tag verifies that an unbiased non-profit organization (the Illinois Crop Improvement Association) has conducted inspections in the production field and in the processing plant. These inspections make certain the seeds are of a particular variety as named and have met certain minimum seed-quality standards. Some seedsmen may have a higher seed quality than others. It pays to read the tag.

## Varieties

Soybean varieties are divided into maturity groups according to their relative time of maturity (Table 14). Varieties of Maturity Group I are nearly full season in northern Illinois, but too early for good growth and yield farther south. In extreme southern Illinois the Maturity Group IV varieties range from early to midseason in maturity.

Table 14. — Characteristics and Parentage of Major Soybean Varieties in Illinois

| Maturity group and variety | Parentage and year released[a] | Flower color | Pubescence color | Pod color | Seed luster | Hilum color[b] |
|---|---|---|---|---|---|---|
| 0 | | | | | | |
| Grant | Lincoln X Seneca (1955) | white | lt. brown | brown | shiny | black |
| Traverse | Lincoln X Mandarin (Ottawa)(1965) | white | gray | brown | shiny | yellow |
| XK 111 | L. Teweles Seed Co. (1971) | white | gray | tan | dull | buff |
| I | | | | | | |
| XK 505 | L. Teweles Seed Co. (1971) | purple | brown | brown | intermediate | black |
| Chippewa | Lincoln$^{2}$ X Richland (1954) | purple | brown | brown | shiny | black |
| Chippewa 64 | Chippewa$^{8}$ X Blackhawk (1964) | purple | brown | brown | shiny | black |
| Rampage | Clark X Chippewa | purple | brown | brown | shiny | black |
| Bombay | farmer selection (1966) | purple | gray | tan | shiny | yellow |
| Hark | Hawkeye X Harosoy (1966) | purple | gray | brown | dull | yellow |
| A-100 | farmer selection (1959) | white | gray | brown | shiny | buff |
| SRF 100 | Soybean Research Foundation (1971) | purple | brown | brown | shiny | black |
| Anoka-II | 42-37 X Korean (1969) | purple | brown | brown | shiny | yellow |
| Dunn | Grant X Chippewa (1969) | purple | lt. brown | brown | shiny | black |
| SRF 150 | Soybean Research Foundation (1972) | purple | gray | brown | dull | yellow |
| SM-2A | Seedmakers, Inc. (1973) | purple | gray | tan | dull | yellow |
| Disoy | [Mandarin (Itaura) X Kanro] X [Richland X Jogun] (1967) | purple | gray | tan | dull | yellow |
| II | | | | | | |
| Harosoy | Mandarin (Ottawa)$^{2}$ X AK (Harrow)(1951) | purple | gray | brown | dull | yellow |
| Harosoy 63 | Harosoy$^{8}$ X Blackhawk (1963) | purple | gray | brown | dull | yellow |
| Carsoy | Harosoy X Capital (1967) | purple | gray | brown | dull | yellow |
| Lindarin 63 | Lindarin$^{8}$ X Mukden (1963) | purple | gray | brown | dull | buff |
| Magna | [Mandarin (Ottawa) X Jogun] (1967) | purple | gray | brown | dull | yellow |
| Peterson Jade | Peterson Seed Co. (1972) | purple | gray | brown | dull green | buff |
| Prize | [Mandarin (Ottawa) X Kanro] (1967) | purple | gray | tan | dull | yellow |
| Provar | Harosoy X Clark (1969) | purple | brown | brown | dull | brown |
| Protana | [CX291-42-1 (Mukden X C1069) X CX258-2-3-2(PI65.338 X C1079)] (1970) | purple | gray | brown | dull | imp. black |
| Amsoy | Adams X Harosoy (1965) | purple | gray | tan | shiny | yellow |
| Amsoy 71 | Amsoy 8 X C1253 (Blackhawk X Harosoy) (1971) | purple | gray | tan | shiny | yellow |
| Hawkeye 63 | Hawkeye$^{7}$ X Blackhawk (1963) | purple | gray | brown | dull | imp. black |
| Beeson | (Blackhawk X Harosoy) X Kent (1968) | purple | gray | brown | shiny | imp. black |
| Marshall | Improved Variety Research, Inc. (1971) | purple | gray | gray | dull | buff |
| XK505 | L. Teweles Seed Co. (1971) | purple | brown | brown | intermediate | black |
| Wells | (Harosoy X C1079) X C1253 (1973) | purple | gray | brown | dull | yellow |
| Bellatti 4-P | Selected by Louis Bellatti (1969) | purple | brown | brown | dull | black |
| Buccaneer | Syler, Inc. (1973) | purple | gray | brown | shiny | yellow |
| SM-IC | Seedmakers, Inc. (1972) | purple | brown | brown | shiny | black |
| SRF 200 | Soybean Research Foundation (1973) | purple | gray | tan | shiny | yellow |
| III | | | | | | |
| Adams | Illini X Dunfield (1948) | white | gray | tan | shiny | buff |
| Shelby | Lincoln$^{2}$ X Richland (1958) | purple | brown | brown | dull | black |
| Wayne | (Lincoln, Richland, CNS) X Clark (1964) | white | brown | brown | shiny | black |
| Calland | (Blackhawk X Harosoy) X Kent (1968) | purple | brown | brown | dull | black |
| Adelphia | (Sib of Kent) X Adams (1966) | white | gray | tan | shiny | buff |
| SRF 300 | Soybean Research Foundation Variety (1969) | white | brown | brown | shiny | black |
| SRF 307 | Soybean Research Foundation (1971) | white | brown | brown | shiny | 30% brown, 70% black |
| Seedmakers 1-E | Seedmakers, Inc. (1971) | purple | gray | tan | shiny | yellow |

*(Table is concluded on next page)*

Table 14. — Concluded

| Maturity group and variety | Parentage and year released[a] | Flower color | Pubescence color | Pod color | Seed luster | Hilum color[b] |
|---|---|---|---|---|---|---|
| Williams | Wayne X L 57-0034 (1972) | white | brown | tan | shiny | black |
| SRF 307P | Soybean Research Foundation (1973) | white | brown | brown | shiny | brown |
| SRF 350 | Soybean Research Foundation (1973) | white | brown | brown | shiny | black |
| XK 585 | L. Teweles Seed Co. (1972) | white | brown | brown | dull | black |
| Kanrich | | purple | gray | brown | dull | light buff |
| IV | | | | | | |
| Columbus | C1069 (Lincoln X Ogden) X Clark | purple | brown | brown | shiny | black |
| Bonus | C12 66R X C 1253 (1972) | purple | gray | brown | dull | imp. black |
| Clark | Lincoln$^2$ X Richland (1953) | purple | brown | brown | dull | black |
| Clark 63 | (Clark$^7$ X CNS) X (Clark$^6$ X Blackhawk) (1963) | purple | brown | brown | dull | black |
| Bellatti L263 | farmer selection (1965) | purple | brown | brown | dull | black |
| Patterson | introduced from Morocco (1965) | white | gray | tan | dull | yellow |
| Cutler | (Lincoln X Ogden) X Clark (1968) | purple | brown | brown | shiny | black |
| Cutler 71 | Cutler$^4$ X Kent — Rpo rxp — SL5 (1971) | purple | brown | brown | shiny | black |
| Custer | (Peking X Scott) X Scott X Blackhawk (1967) | purple | gray | brown | shiny | imp. black |
| Kent | (Lincoln X Ogden) (1961) | purple | brown | brown | intermediate | black |
| Mitchell | Midwest Research Corp. (1973) | purple | tawny | brown | dull | lt. brown |
| Delmar | P.I.70218 X Lincoln X FC33,243 (1963) | white | gray | brown | dull | yellow |
| Scott | (Sib of Lee) (Lincoln X Richland) (1958) | purple | gray | brown | shiny | imp. black |
| SRF 400 | Soybean Research Foundation (1971) | purple | brown | brown | dull | black |
| SRF 450 | Soybean Research Foundation (1972) | purple | brown | brown | shiny | black |
| Wye | 2nd cycle intermated population of Adams, Lincoln, Perry, Wabash, C799, C985, FC (1972) 33,243, and L46-1503 | white | brown | brown | shiny | black |
| V | | | | | | |
| Dare | Hill X Roanoke X Ogden (1965) | white | gray | tan | shiny | buff |
| Dyer | Hill X (Lee$^2$ X Peking)$^6$ (1967) | purple | brown | tawny | shiny | black |
| Hill | (Dunfield X Haberlandt) X Sib of Lee (1959) | white | brown | tan | shiny | brown |
| Mack | [(NC55(3) X S62-5-16-12) X RA-63-19-2] X Lee 68 (1972) | purple | brown | tan | shiny | black |
| Essex | Lee X 55-7075 (1973) | purple | gray | brown | | buff |
| Forrest | (Dyer X Bragg)(1973) | white | brown | | shiny | black |
| Oksoy | Scott (6) X Blackhawk (1971) | purple | gray | | | buff |
| VI | | | | | | |
| Ogden | Tokio X PI 54,610 (1942) | purple | gray | brown | dull[c] | imp. black |
| Hood | Roanoke X line from Ogden X CNS (1958) | purple | gray | tan | shiny | buff |
| Lee | S-100 X CNS (1954) | purple | brown | tan | shiny | black |
| Pickett | [(Sib of Lee)$^6$ X Dorman] X [Lee$^4$ X Peking] (1965) | purple | gray | tan | shiny | imp. black |
| Pickett 71 | Pickett X Phytophthora Res. Lee (1971) | purple | gray | tan | shiny | imp. black |

[a] Superscript indicates the number of crosses in a backcrossing program.
[b] imp. = imperfect.
[c] Seed coat of Ogden is green. All others listed have yellow seed coat.

*Maturity Group I*

**Chippewa 64** is an early variety adapted to the northern states and performs like its namesake Chippewa, except that it carries resistance to phytophthora root rot. Chippewa and Chippewa 64 account for about two-thirds of the soybean acreage in Wisconsin and Minnesota, but grow them only in northern Illinois and only when you want earliness, since the later varieties outyield them throughout Illinois.

**Rampage** was released in 1970. It matures 1 to 2 days earlier than Hark or 2 to 3 days later than Chippewa 64. It is 1 inch shorter than Chippewa 64 in height and slightly less lodging resistant. Rampage is susceptible to phytophthora root rot, but resistant to shattering.

**Hark** is a variety adapted to northern Illinois where it has yielded as well as most Group II varieties, but less than Amsoy and Corsoy. It has good height for an early variety, but has a tendency to shatter when grown in cen-

Table 15. — Soybean Yields, 1973-75, Bushels per Acre

| | DeKalb | Pontiac | Urbana | Girard | Brownstown | Belleville | Eldorado |
|---|---|---|---|---|---|---|---|
| Hark | 50 | 35 | .. | .. | .. | .. | .. |
| Hodgson | 49 | 37 | .. | .. | .. | .. | .. |
| Steele | 44 | 37 | .. | .. | .. | .. | .. |
| Wells | 51 | 39 | .. | .. | .. | .. | .. |
| Harcor | .. | 40 | 57 | .. | .. | .. | .. |
| Corsoy | 52 | 39 | 56 | 44 | 39 | .. | .. |
| Amsoy 71 | 53 | 36 | 55 | 43 | 40 | .. | .. |
| Beeson | 49 | 36 | 55 | 42 | 38 | .. | .. |
| Wayne | 45 | 42 | 49 | 47 | .. | .. | .. |
| Woodworth | .. | .. | 51 | 46 | 42 | 55 | 44 |
| Calland | .. | .. | 50 | 37 | 41 | 52 | 44 |
| Williams | .. | .. | 52 | 49 | 39 | 54 | 48 |
| Cutler 71 | .. | .. | .. | .. | 40 | 53 | 45 |
| Kent | .. | .. | .. | .. | 39 | 52 | 48 |
| Columbus | .. | .. | .. | .. | .. | .. | 45 |

tral Illinois where it ripens early while the weather is still warm. This variety, like Wayne, may show iron-deficiency chlorosis when planted on soils of high pH (7 +).

A-100 is an early variety similar to Hark in maturity. It is a farmer selection from Minnesota. It is shorter than Hark but more resistant to shattering and has yielded about the same as Hark. Its tendency to lodge is slightly greater than Hark.

*Maturity Group II*

**Harosoy** and **Harosoy 63** are similar except that Harosoy 63 is resistant to phytophthora root rot. This can be of great importance on low ground or in wet springs when phytophthora can cause severe stunting and killing of susceptible Harosoy. Harosoys were the top-yielding varieties in northern Illinois before the release of Corsoy. Continue to use Harosoy 63 on land subject to flooding or where phytophthora root rot in a problem, since Corsoy is very susceptible. Both varieties have a tendency to shatter when conditions are overly dry at harvest time.

**Wells** was developed at Purdue University and released in 1973. It is similar to Corsoy in plant height and seed size, but matures 1 to 2 days earlier. Wells is superior to Amsoy 71, Beeson, and Corsoy in lodging resistance. It is resistant to phytophthora rot and frogeye leafspot race 2.

**Corsoy** was released in 1967. It is similar to Amsoy in growth habit, but averages 2 inches shorter. It is susceptible to phytophthora root rot, so grow it where this disease is not a problem. Corsoy has yielded 1 to 2 bushels per acre more than Amsoy and matured 1 to 3 days earlier. Lodging resistance of Corsoy is slightly less than Amsoy. Corsoy and Amsoy should replace much of the acreage of older Group II varieties except where phytophthora root rot is present.

**Provar** was released in 1969 as a special purpose high-protein variety. It will range from 2.5 to 4.5 percent higher in protein than most other soybean varieties. It matures one day later than Corsoy and two days earlier than Amsoy. It is comparable to Amsoy in lodging resistance, but is 3 to 4 inches shorter. It is susceptible to phytophthora root rot and yields slightly less than Corsoy or Amsoy.

**Amsoy** is a high-yielding variety, second only to Corsoy among the Group II varieties, and is a very popular variety. It is very susceptible to phytophthora root rot and purple stain of the seed coat. Purple stain is occasionally a problem, usually occurring in southern Illinois. The lodging resistance of Amsoy is superior to most other Group II varieties.

**Amsoy 71** was developed at Purdue University. It is similar to Amsoy, except that it is resistant to phytophthora root rot, while Amsoy is susceptible.

**Protana** was released in 1970 as a high-protein variety resistant to phytophthora root rot. It will range from 2 to 4 percent higher in protein than currently grown commercial soybean varieties. It matures about two days later than Amsoy and is comparable to Amsoy in lodging resistance and seed size. It is 3 to 4 inches shorter. Yield of Protana is slightly less than Amsoy and Corsoy.

**Beeson** is resistant to phytophthora root rot. It was released by Purdue University in August, 1968. The variety has yielded nearly as well as Amsoy when root rot was not present. In the presence of root rot, Beeson has yielded much more than Amsoy or Corsoy. Beeson matures about 3 days later than Amsoy and 6 days later than Corsoy. Lodging resistance of Beeson is slightly greater than Amsoy or Corsoy. It is similar in height to Corsoy and 1 to 3 inches shorter than Amsoy. It has a spreading leaf canopy.

*Maturity Group III*

**Wayne** is a high-yielding variety in central and south central Illinois. It has some tendency to shatter and develops iron-deficiency chlorosis (yellowing of leaves) on high-lime soils (pH 7+). It is susceptible to pod and stem blight, so at times will have poor seed quality. Its advantages are resistance to bacterial pustule and high yields.

**Calland** has phytophthora root rot resistance and was released by Purdue University in August, 1968. It has yielded nearly as well as Wayne in the absence of phytophthora root rot. Where phytophthora root rot is severe, Calland has yielded much more than Wayne. Calland matures 1 to 2 days later than Wayne, averages about 1 inch taller, and has a little greater resistance to lodging.

**Adelphia**, released in New Jersey in 1966, showed resistance to a seed-quality problem similar to the one in southern Illinois. The yield of Adelphia has been lower than Wayne and other Group III varieties. The variety has a high seed quality. Interest is being maintained in Adelphia to test for resistance to the purple stain and other seed-quality problems that often occur in southern Illinois.

**Williams** was developed by the USDA in cooperation with the University of Illinois and was released in 1972. It is superior to other varieties adapted to central and southern Illinois in seed quality (freedom from wrinkling, growth cracks, greenishness, and moldy or rotten seeds). It matures about 3 days later than Wayne but is similar in plant height and seed size. Williams is superior to both Wayne and Calland in lodging and shatter resistance. It is resistant to bacterial pustule and powdery mildew. Williams is classed as susceptible to phytophthora root rot but appears to have some tolerance to this disease.

*Maturity Group IV*

**Bonus** was developed by the USDA in cooperation with Purdue University. It matures about 2 days earlier than Cutler 71 and grows about 3 to 4 inches taller. The seed of Bonus is smaller than Cutler 71 and the quality (freedom from wrinkling, growth cracks, greenness, and moldy or rotten seeds) is better. Bonus is resistant to phytophthora root rot and susceptible to Frogeye Race 2, bacterial pustule, and downy mildew. It tends to shatter more than Cutler 71. Bonus is comparable to other varieties in oil content, but is 1 to 2 percent higher in protein content.

**Clark** and **Clark 63** are similar, except Clark 63 is resistant to bacterial pustule leaf spot and phytophthora root rot. Bacterial pustule is a widespread leaf spot disease in southern Illinois, and in wet fields phytophthora root rot can cause severe damage in that area. Neither disease will develop on Clark 63, so this is the preferred variety. The high yield and excellent lodging resistance of these two varieties made them the leading varieties in southern Illinois.

**Cutler**, a high-yielding variety, is moderately susceptible to phytophthora root rot. It was released in 1968 by Purdue University. In the absence of phytophthora root rot, Cutler yields 3 to 4 bushels more than Clark 63 and 1 bushel more than Kent. Cutler is 2 to 3 days later maturing than Clark 63 and 5 days earlier than Kent.

**Cutler 71** was developed at Purdue University. It is similar to Cutler, except that it is resistant to phytophthora root rot and Cutler is susceptible.

**Wye** was developed by the USDA in cooperation with the University of Maryland. It was released in 1972. It matures 2 to 3 days later than Cutler 71. Wye grows about 6 inches shorter and is a little more resistant to lodging than Cutler 71. It is susceptible to bacterial pustule, downy mildew, and phytophthora root rot. It is resistant to Frogeye Race 2 and shattering. Limited testing in Illinois indicates that its performance may not be equal to Cutler 71 and Bonus.

**Kent** is a late variety over much of Illinois, but in the southern quarter of the state it ripens at the same time as earlier varieties do farther north. It has been a top-yielding variety in the southern quarter. It has excellent lodging resistance, but in some years it has a tendency to shatter when it is not harvested immediately after ripening.

**Columbus** was developed at Kansas State University and released to certified seed growers in 1971. It matures about 4 days later than Kent and 7 to 9 days later than Cutler 71. It is similar to Cutler 71 in plant height and lodging resistance. Unlike most Group IV varieties Columbus has the determinate type of growth.

*Maturity Group V*

**Mack** was developed by the USDA in cooperation with the Arkansas Agricultural Experiment Station. It was released in 1972. Mack grows about 2 inches shorter than Dare and is comparable in maturity. It is resistant to bacterial pustule, phytophthora root rot, cyst nematode race 3, and shattering. It is comparable to other group V varieties in oil and protein content. Mack has not been tested in Illinois, however its performance in the Delta region has been comparable to Dare.

**Dare** is a 1965 release and was increased by certified seed growers in Missouri, Oklahoma, Maryland, Virginia and North Carolina. It has had limited testing in the southern tip of Illinois and has performed very well. It is suggested for growing in that area whenever a late variety is desired because it has outyielded Hill, Ogden, and Lee, and it does not have the poor seed quality of the Group IV varieties. It has moderate resistance to phytophthora root rot.

**Dyer** is an early maturing variety in Group V that was released in 1967 by the USDA and agricultural experiment stations of Mississippi and Tennessee. It is resistant to soybean cyst nematode, two root-knot nematodes, bacterial pustule, wildfire, and target spot. It is more susceptible to phytophthora root rot than Hill and less shatter resistant than Hill. Dyer has yielded slightly less than Hill in the absence of soybean cyst nematode.

Table 16. — Disease Resistance of Soybean Varieties

| Maturity group and variety | Phytophthora root rot | Bacterial pustule | Bacterial blight | Downy mildew | Frogeye leaf spot Race 2 |
|---|---|---|---|---|---|
| I | | | | | |
| Chippewa 64 | ++ | – | + | – | – |
| Rampage | – – | – | – | – | – |
| Hark | – – | – | – | – | – |
| A-100 | – | – | – | – | – |
| II | | | | | |
| Harosoy 63 | ++ | – | – | + | – |
| Provar | – – | – | – | – | – – |
| Wells | ++ | – | – | + | + |
| Corsoy | – – | – | – | + | – |
| Amsoy | – – | – | – | + | – |
| Amsoy 71 | ++ | – | – | + | – |
| Beeson | ++ | – | – | + | + |
| III | | | | | |
| Wayne | + | ++ | – | – – | + |
| Calland | ++ | – | – | + | – |
| Williams | + | ++ | – | – – | – |
| IV | | | | | |
| Bonus | ++ | – | – | – – | – – |
| Clark 63 | ++ | ++ | – | – – | – |
| Cutler | + | – | – | – | + |
| Cutler 71 | ++ | – | – | – | ++ |
| Kent | – | – | – | + | ++ |
| Columbus | – | – | – | | |
| V | | | | | |
| Dare | + | ++ | | + | |
| Forrest | ++ | ++ | | + | |
| Mack | ++ | ++ | | + | |
| Essex | ++ | ++ | | + | |

++ = resistant; + = slightly susceptible; – = susceptible; – – = very susceptible.

Essex was developed at the Virginia Agricultural Experiment Station. It matures about 2 days earlier than Dare, grows about 4 to 6 inches shorter, and is more resistant to lodging than Dare. It is resistant to bacterial pustule, several races of downy mildew, frogeye leafspot, and moderately resistant to phytophthora rot. It is susceptible to the soybean cyst nematode.

Forrest was developed at the Delta Branch Agricultural Experiment Station, Mississippi. It is similar to Dare in maturity. It is resistant to races 1 and 3 of the soybean cyst nematode, bacterial pustule, wild fire, target spot, and moderately resistant to phytophthora rot. It has excellent resistance to shattering.

*Private Varieties*

Several soybean varieties developed by privately financed research programs have been released recently. These varieties are handled within the seed trade as proprietary items, i.e., the property of the developer.

Following are brief descriptions of several private varieties. These have met the National Certified Soybean Variety Review Board criteria of distinctiveness and as meriting certification.

**SRF-100** is a narrow-leaf variety of Group I maturity developed by the Soybean Research Foundation. In plant type, oil and protein content, and maturity it is quite similar to Chippewa 64. It has purple flowers, tawny pubescence, brown pods, shiny yellow seed coat, and black hila. It is resistant to phytophthora root rot. Unlike Chippewa 64 it has lanceolate-shaped leaves and bears a considerable number of four-seeded pods. Seed size of SFR 100 is slightly smaller than Chippewa 64.

**SRF-150** is a narrow-leaf variety developed by the Soybean Research Foundation. This variety matures about two days earlier and grows about 1 inch shorter than Hark. It is comparable to Hark in lodging resistance. It has purple flowers, gray pubescence, dull yellow seed coat, and yellow hila.

**SRF-200** was released in 1973. It is a narrow-leaf variety of Group II maturity developed by the Soybean

Table 17. — Relative Soybean Variety Performance at Urbana, Illinois

| Maturity group and variety | Maturity date | Lodging | Plant height | Seed quality | Seeds per pound[a] | Seed content | |
|---|---|---|---|---|---|---|---|
| | | | | | | Protein | Oil |
| I | | *score*[b] | *inches* | *score*[c] | *number* | *percent* | *percent* |
| Chippewa 64 | Aug. 31 | 1.3 | 33 | 2.4 | 2,900 | 41.5 | 22.1 |
| Hark | Sept. 7 | 1.3 | 35 | 1.6 | 2,700 | 41.8 | 22.5 |
| II | | | | | | | |
| Wells | Sept. 8 | 1.3 | 39 | 2.1 | 2,850 | 40.7 | 22.6 |
| Corsoy | Sept. 8 | 2.3 | 40 | 1.9 | 2,900 | 40.2 | 22.8 |
| Amsoy 71 | Sept. 11 | 1.8 | 42 | 2.2 | 2,700 | 39.1 | 23.4 |
| Beeson | Sept. 13 | 1.6 | 41 | 2.2 | 2,400 | 40.3 | 22.3 |
| III | | | | | | | |
| Wayne | Sept. 23 | 2.3 | 43 | 2.4 | 2,700 | 41.8 | 21.8 |
| Calland | Sept. 27 | 2.1 | 43 | 2.9 | 2,600 | 40.1 | 21.4 |
| Williams | Sept. 27 | 1.5 | 43 | 2.0 | 2,600 | 40.6 | 22.6 |
| IV | | | | | | | |
| Bonus | Oct. 2 | 2.3 | 48 | 2.1 | 2,600 | 43.1 | 21.7 |
| Cutler | Oct. 6 | 1.6 | 44 | 2.1 | 2,400 | 40.7 | 21.9 |
| Cutler 71 | Oct. 6 | 1.8 | 46 | 2.3 | 2,400 | 40.1 | 22.2 |
| Kent | Oct. 9 | 1.9 | 43 | 2.3 | 2,500 | 39.8 | 22.4 |

[a] USDA Regional Uniform Test average.
[b] Lodging score: 1 = erect, 5 = prostrate.
[c] Seed quality score: 1 = excellent, 5 = very poor (wrinkled, shriveled, green, moldy, imperfect seed coat, or other defects).

Research Foundation at Mason City, Illinois. It ripens about one day earlier than Amsoy 71. It has purple flowers, gray pubescence, and tan pods. Many of the pods are four-seeded. The seeds are shiny yellow with yellow hila. SRF-200 is classed as a "thin-line" variety, being similar to Amsoy 71 in this respect. It is resistant to Race 1 phytophthora root rot. Foundation seed will be maintained by Soybean Research Foundation. Other recognized classes are Registered and Certified.

**SRF-300** was developed by the Soybean Research Foundation, Mason City. The variety is similar to Wayne in maturity and lodging resistance. The leaves are narrow and lance shaped. It is susceptible to phytophthora root rot. SRF-300 grows about an inch taller than Wayne. The seed of SRF-300 is somewhat smaller than Wayne seed. Seed of SRF-300 is available only from member companies of the Soybean Research Foundation.

**SRF-307P** was released in 1973. It is a narrow leaf variety of Group III maturity developed by Soybean Research Foundation of Mason City, Illinois. SRF-307P is SRF-307 to which resistance to Race 1 of phytophthora root rot has been added. In all other aspects except hilum color it is nearly identical to SRF-307. Hilum color in 307P is brown. SRF-307P has white flowers, brown pubescence, brown pod, shiny yellow seed coat, brown hilum, and lanceolate leaf shape.

**SRF-350** was released in 1973. It is a narrow leaf variety of Group III maturity developed by Soybean Research Foundation. It matures about the same time as Williams. It has white flowers, brown pubescence, and brown pods. Many of its pods are four-seeded and some five-seeded pods occur. The seeds are shiny yellow with black hilum.

**SRF-400** is a narrow-leaf variety of Group IV maturity developed by the Soybean Research Foundation. In plant type, oil and protein content, and maturity it is quite similar to Clark 63. It has purple flowers, tawny pubescence, brown pods, black hila, and dull yellow seed coat, and is resistant to phytophthora rot. Unlike Clark 63, it has lanceolate-shaped leaves and bears many four-seeded pods. Seed size averages 14.3 grams per 100 seeds compared with 16.1 for Clark 63.

**SRF-450** was released in 1971. SRF-450 is in Group IV, maturing five days later than Bonus and two days later than Cutler 71. It is a bushy type plant, with narrow leaves, and produces a high number of four-seeded pods. It has purple flowers, brown pubescence, brown pod color, and round seed shape with a black hilum.

**Bellatti L263** originated as a selection from Bavender Special. It is similar to Clark in yield, maturity, standability, and appearance. Bellatti L263 was released in 1965 by Mr. Louis Bellatti, Mt. Pulaski.

**Bellatti 4P** was developed by Mr. Louis Bellatti and released in 1969. This is a selection from a natural cross in a field of Bavender Special. It is classed in Maturity Group II and is similar in maturity to the Amsoy variety. Distinguishing characteristics of this variety are purple flowers, brown pods, brown pubescence, dull yellow seed coat with black hilum. The seed shape tends to be slightly elongated. The plant's type of growth is somewhat like Harosoy, but slightly shorter in plant height, producing a branching canopy. Bellatti 4P has a tendency to produce a relatively high number of pods containing four beans.

**Buccaneer** was released in 1973. It is a privately developed variety and released by Syler, Inc., Plymouth, Indiana. It is a Group II variety maturing at the same time as Amsoy 71. It has purple flowers, gray pubescence, brown pod color, yellow seed coat with shiny luster, and a yellow hilum. The plant grows to about 40 inches tall with round to slightly elongated seed.

**Seedmakers 1-E** was developed by Louis Bellatti, Mt. Pulaski, Illinois, and is distributed by Seedmakers, Inc., Princeville, Illinois.

Seedmakers 1-E is comparable to Wayne in maturity, grows 6 to 8 inches taller and is less lodging resistant. It has purple flowers, gray pubescence, tan pods, shiny yellow seed coat, and yellow hila.

**Seedmakers-2A** was released in 1973. It is a privately developed variety with purple flowers, gray pubescence, tan pod color, yellow seed coat color with a dull luster and yellow hilum. SM-2A is in Group I, maturing about the same date as Hark. It is distributed by members of Seedmakers, Inc., Princeville, Illinois.

**Seedmakers-1C** was released in 1972. It is a privately developed variety with purple flowers, brown pubescence, and pod color. The seed has a black hilum on a shiny yellow seed coat. Seedmakers-1C is a Group II variety maturing two days later than Corsoy and one day later than Amsoy 71. It is distributed by members of Seedmakers, Inc., Princeville, Illinois.

**Mitchell** was released in 1973. This variety was developed by a private plant breeder and is distributed by members of Midwest Research Corporation. Mitchell has purple flower color, tawny pubescence, brown pod color. Seed is a dull yellow seed coat with a light brown hilum. Mitchell is in Group IV, maturing about one day later than Cutler and four days later than Kent. Plant type may be described as bushy and plant habit as indeterminate.

**Marshall** was developed by Improved Variety Research, Inc., Adel, Iowa. It is comparable to Amsoy in maturity, plant height, and lodging resistance. It is a little higher in protein and lower in oil than Amsoy and has purple flowers, gray pubescence, gray pods, dull yellow seed coat, and a buff hila.

**XK-111** was developed by the L. Teweles Seed Co., Clinton, Wisconsin. It is a very early variety and is comparable to Merit in maturity. It has white flowers, gray pubescence, tan pods, a dull yellow seed coat, and buff hila.

**XK-505** was developed by the L. Teweles Seed Co., Clinton, Wisconsin. It grows about 3 inches taller than Amsoy and matures one to two days later. It has purple flowers, brown pubescence, brown pods, and yellow seed coat with black hila. It is resistant to phytophthora rot.

**XK-585** was released in 1972. It was developed and released by L. Teweles Seed Co., Muscatine, Iowa. It has white flowers, brown pubescence, brown pod, dull yellow seed coat, black hilum, round seed. XK-585 is in Group III, maturing two days earlier than Wayne. Breeder's seed will be maintained by the developer. Other recognized classes are Foundation and Certified seed. No Registered class will be allowed.

# WHEAT

## Time of Seeding

Wheat varieties that are resistant to Hessian fly may be planted before the "fly-free date." Varieties susceptible to Hessian fly should not be planted until the fly-free date. The average fly-free date suggested by Extension entomologists for different areas of the state are shown in Table 18.

Early seeded wheat is not only subject to attack by Hessian fly, it is also subject to damage by disease, especially if it is planted more than 10 days or two weeks prior to the Hessian fly-free date. Therefore, even the varieties that are resistant to the insect should not be planted extremely early.

## Rate of Seeding

Rate-of-seeding trials involving several different wheat varieties have been conducted in Illinois. The results of these trials indicate that one and a half bushels (90 pounds) of good seed is adequate when planting at the normal time. The rate may be increased if seeding is delayed well past the fly-free date.

## Depth of Seeding

Wheat should not be planted more than 1 to 2 inches deep. Deeper planting may result in poor emergence. This is particularly true of the semi-dwarf varieties because coleoptile length is positively correlated with plant height.

## Width of Row

Research on row width shows no advantage for planting wheat in rows narrower than the 7 or 8 inches, which is considered normal. Yield is not improved by planting in narrower rows. It is usually reduced by wider rows as the following table shows.

| *Row spacing* | *Two-year average yield at Urbana* |
|---|---|
| 8 inch spacing | 37.8 bushels |
| 16 inch spacing | 31.6 bushels |
| 24 inch spacing | 27.2 bushels |

## Varieties: Hard Red Winter

**Centurk** was developed at the University of Nebraska and released in 1970. The name Centurk is a contraction of "Centennial Turkey" derived from the Turkey wheat parentage in the cross and the upcoming centennial of the introduction of Turkey wheat into the United States in 1873-74. Centurk matures at the same time as Scout 66, but is from 4 to 6 inches shorter. It possesses good rust resistance and has yielded better than other hard wheats in Illinois.

Table 18. — Average Date of Seeding Wheat for Highest Yield

| County | Average date of seeding wheat for highest yield | County | Average date of seeding wheat for highest yield |
|---|---|---|---|
| Adams | Sept. 30-Oct. 3 | Lee | Sept. 19-21 |
| Alexander | Oct. 12 | Livingston | Sept. 23-25 |
| Bond | Oct. 7-9 | Logan | Sept. 29-Oct. 3 |
| Boone | Sept. 17-19 | Macon | Oct. 1-3 |
| Brown | Sept. 30-Oct. 2 | Macoupin | Oct. 4-7 |
| Bureau | Sept. 21-24 | Madison | Oct. 7-9 |
| Calhoun | Oct. 4-8 | Marion | Oct. 8-10 |
| Carroll | Sept. 19-21 | Marshall-Putnam | Sept. 23-26 |
| Cass | Sept. 30-Oct. 2 | Mason | Sept. 29-Oct. 1 |
| Champaign | Sept. 29-Oct. 2 | Massac | Oct. 11-12 |
| Christian | Oct. 2-4 | McDonough | Sept. 29-Oct 1 |
| Clark | Oct. 4-6 | McHenry | Sept. 17-20 |
| Clay | Oct. 7-10 | McLean | Sept. 27-Oct. 1 |
| Clinton | Oct. 8-10 | Menard | Sept. 30-Oct. 2 |
| Coles | Oct. 3-5 | Mercer | Sept. 22-25 |
| Cook | Sept. 19-22 | Monroe | Oct. 9-11 |
| Crawford | Oct. 6-8 | Montgomery | Oct. 4-7 |
| Cumberland | Oct. 4-5 | Morgan | Oct. 2-4 |
| DeKalb | Sept. 19-21 | Moultrie | Oct. 2-4 |
| DeWitt | Sept. 29-Oct. 1 | Ogle | Sept. 19-21 |
| Douglas | Oct. 2-3 | Peoria | Sept. 23-28 |
| DuPage | Sept. 19-21 | Perry | Oct. 10-11 |
| Edgar | Oct. 2-4 | Piatt | Sept. 29-Oct. 2 |
| Edwards | Oct. 9-10 | Pike | Oct. 2-4 |
| Effingham | Oct. 5-8 | Pope | Oct. 11-12 |
| Fayette | Oct. 4-8 | Pulaski | Oct. 11-12 |
| Ford | Sept. 23-29 | Randolph | Oct. 9-11 |
| Franklin | Oct. 10-12 | Richland | Oct. 8-10 |
| Fulton | Sept. 27-30 | Rock Island | Sept. 20-22 |
| Gallatin | Oct. 11-12 | St. Clair | Oct. 9-11 |
| Greene | Oct. 4-7 | Saline | Oct. 11-12 |
| Grundy | Sept. 22-24 | Sangamon | Oct. 1-5 |
| Hamilton | Oct. 10-11 | Schuyler | Sept. 29-Oct. 1 |
| Hancock | Sept. 27-30 | Scott | Oct. 2-4 |
| Hardin | Oct. 11-12 | Shelby | Oct. 3-5 |
| Henderson | Sept. 23-28 | Stark | Sept. 23-25 |
| Henry | Sept. 21-23 | Stephenson | Sept. 17-20 |
| Iroquois | Sept. 24-29 | Tazewell | Sept. 27-Oct. 1 |
| Jackson | Oct. 11-12 | Union | Oct. 11-12 |
| Jasper | Oct. 6-8 | Vermilion | Sept. 28-Oct. 2 |
| Jefferson | Oct. 9-11 | Wabash | Oct. 9-11 |
| Jersey | Oct. 6-8 | Warren | Sept. 23-27 |
| Jo Daviess | Sept. 17-20 | Washington | Oct. 9-11 |
| Johnson | Oct. 10-12 | Wayne | Oct. 9-11 |
| Kane | Sept. 19-21 | White | Oct. 9-11 |
| Kankakee | Sept. 22-25 | Whiteside | Sept. 20-22 |
| Kendall | Sept. 20-22 | Will | Sept. 21-24 |
| Knox | Sept. 23-27 | Williamson | Oct. 11-12 |
| Lake | Sept. 17-20 | Winnebago | Sept. 17-20 |
| LaSalle | Sept. 19-24 | Woodford | Sept. 26-28 |
| Lawrence | Oct. 8-10 | | |

**Ottawa** is a red chaff variety released in Kansas in 1960. It is similar to Pawnee in yield and maturity, but it has better grain quality and improved straw strength. It is resistant to stem rust but is susceptible to loose smut, which could become a problem. Ottawa has an excellent yield record in Illinois yield trials and on Illinois farms.

Table 19. — Yield Record of Leading Varieties in University of Illinois and Southern Illinois University Tests

| | DeKalb | | | Urbana | | | Brownstown | | | Belleville[a] | | | Dixon Springs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1975 | | 1973-75 | 1975 | | 1973-75 | 1975 | | 1974-75 | 1975 | | 1974-75 | 1975 | |
| | Bul/A. | T.W. | Bu./A. | Bu./A. | T.W. | Bu./A. | Bu./A. | T.W. | Bu./A. | Bu./A. | T.W. | Bu./A. | Bu./A. | T.W. |
| SOFT WHEAT | | | | | | | | | | | | | | |
| Abe | 51 | 59 | 48 | 67 | 61 | 59 | 58 | 57 | 44 | 45 | 59 | 40 | 37 | 57 |
| Arthur | 42 | 58 | 42 | 67 | 61 | 58 | 53 | 57 | 43 | 44 | 59 | 39 | 33 | 57 |
| Arthur 71 | 42 | 59 | 44 | 64 | 60 | 56 | 59 | 59 | 44 | 40 | 59 | 38 | 37 | 57 |
| Blueboy II | 43 | 49 | 47 | 75 | 58 | 70 | 71 | 56 | 47 | 41 | 53 | 32 | 36 | 56 |
| Oasis | 50 | 56 | 47 | 64 | 60 | 58 | 59 | 57 | 47 | 42 | 59 | 37 | 35 | 57 |
| Stoddard | 51 | 57 | .. | 68 | 62 | .. | 56 | 58 | 43 | 41 | 59 | .. | 38 | 57 |
| Ruler | 50 | 57 | .. | 56 | 60 | .. | 60 | 58 | .. | .. | .. | .. | .. | .. |
| HARD WHEAT | | | | | | | | | | | | | | |
| Centurk | 41 | 56 | 44 | 60 | 61 | 53 | 50 | 58 | 40 | | | | | |
| Gage | 39 | 56 | 44 | 58 | 61 | 48 | 48 | 57 | 38 | | | | | |
| Homestead | 41 | 57 | 40 | 53 | 60 | 45 | 40 | 57 | 31 | | | | | |
| Parker | 31 | 58 | 34 | 58 | 62 | 46 | 48 | 59 | 35 | | | | | |
| Sentinel | 40 | 57 | 44 | 53 | 60 | 47 | 45 | 57 | 35 | | | | | |
| Trison | 39 | 57 | .. | 60 | 62 | .. | 41 | 56 | .. | | | | | |
| Sage | 40 | 57 | .. | 52 | 60 | .. | .. | .. | .. | | | | | |

[a] Southern Illinois University Research Center.

Though its chaff color is principally red, it normally has a small number of white chaff heads and certain environmental conditions can increase this number.

Gage, released by Nebraska in 1963, appears to be well adapted to Illinois. Similar to Pawnee in maturity and straw strength, it has improved resistance to rust and soil-borne mosaic. Gage has performed well in Illinois trials, generally outyielding both Pawnee and Ottawa by several bushels per acre. It is comparable to Pawnee in straw strength.

**Scout**, a 1964 release from Nebraska, has yielded well in Illinois trials. It is similar to Gage in maturity, straw height, and strength. It is susceptible to soil-borne mosaic and leaf rust.

**Parker** is a white chaff variety released in Kansas in 1966. It matures earlier than Gage or Pawnee but slightly later than Triumph. Parker has shorter straw than other hard wheat varieties grown in Illinois. Straw strength is excellent. It is resistant to leaf rust and races A and B of Hessian fly. It is susceptible to soil-borne mosaic, stem rust, bunt, and loose smut. The kernel is mid-sized to small, but test weight is high.

**Triumph** is a bearded white chaff wheat developed in Oklahoma in 1940. It is shorter than Pawnee and matures three or four days earlier. It is susceptible to mosaic, leaf and stem rust, and bunt; however it has a good test weight and yield record in Illinois.

**Homestead** was developed at the University of Nebraska and released in 1972. Homestead is similar to Parker and Scout 66 in maturity. It is 4 to 5 inches shorter than Parker. It has good straw strength, but is as lodging resistant as Parker. Homestead is resistant to soil-borne mosaic and stem rust. It is susceptible to leaf rust.

Sentinel was developed at the University of Nebraska and released in 1973. Sentinel is about one day later than Homestead and grows slightly taller. It tends to lodge slightly more than Homestead. Sentinel is resistant to stem rust, susceptible to leaf rust and Hessian fly, and moderately susceptible to soil-borne mosaic.

## Varieties: Soft Red Winter

**Abe** is a soft red winter wheat variety released by Purdue University and the USDA in 1972. The parentage of Abe is similar to that of Arthur. Abe is similar to Arthur in lodging resistance, maturity, and weight per bushel. Under some conditions it will be slightly shorter.

Abe is resistant to Hessian fly, leaf rust, stem rust, powdery mildew, and soil-borne mosaic.

**Arthur** is a 1967 release by the Purdue Agricultural Experiment Station and the USDA. It has been a high-yielding variety in Illinois tests with excellent test weight. It is as winter hardy as Monon, is beardless, white chaffed, and early maturing, and has a short, stiff straw. Arthur responds well to high fertility. It is moderately resistant to leaf rust, and has good resistance to stem rust, powdery mildew, loose smut, soil-borne mosaic, and race A of the Hessian fly.

**Arthur 71**, released in 1971 by Purdue, is comparable to Arthur, except it is resistant to races A and B Hessian fly and is more resistant to leaf rust than Arthur.

**Benhur** was released in 1966 by the Purdue Agricultural Experiment Station and the USDA. It is a white

Table 20. — 1975 Wheat Variety Demonstration Yields, Hard Wheat Varieties

| County | Centurk | | Gage | | Homestead | | Parker | | Sentinel | | Trison | | Triumph | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. |
| Henderson | 38 | 59 | 33 | 59 | 39 | 60 | 35 | 59 | 41 | 61 | 43 | 62 | 35 | 61 |
| St. Clair #1 | 44 | 58 | .. | .. | 34 | 57 | 43 | 59 | 43 | 57 | 51 | 60 | .. | .. |
| St. Clair #2 | 64 | 58 | .. | .. | 55 | 59 | 58 | 61 | 61 | 58 | 61 | 61 | .. | .. |
| Madison | 51 | 59 | 58 | 60 | 51 | 58 | 52 | 61 | 54 | 58 | 54 | 60 | .. | .. |
| Stephenson | 45 | 55 | 47 | 57 | 42 | 57 | 35 | 59 | 51 | 57 | 26 | 55 | .. | .. |
| DeKalb | 41 | 56 | 39 | 56 | 41 | 57 | 31 | 58 | 40 | 57 | 39 | 57 | .. | .. |
| Warren | 62 | .. | 61 | .. | 59 | .. | 63 | .. | 60 | .. | 66 | .. | .. | .. |
| Shelby | 55 | 60 | 58 | 60 | 46 | 60 | 55 | 60 | 53 | 60 | 45 | 62 | .. | .. |
| Average | 49 | 58 | 49 | 58 | 46 | 58 | 45 | 59 | 50 | 59 | 45 | 59 | .. | .. |

chaff, beardless variety that matures 1 to 2 days earlier than Monon and under some conditions is as much as 3 inches shorter. It is superior to Monon in leaf and stem rust, Hessian fly, and lodging resistance. Under some conditions the chaff and stems may turn dark in color. This tendency, inherited from one of its parents, does not affect its yield.

**Monon**, a beardless white chaff variety, was released by Purdue in 1959. It grows 2 or 3 inches shorter than Knox and matures about 1 day earlier. It has more lodging resistance than Knox and Vermillion and is equal to Vermillion and better than Knox in winter hardiness. Monon is resistant to soil-borne mosaic. It is susceptible to stem rust, loose smut, bunt, and powdery mildew.

**Oasis** was developed by Purdue University and released in 1973. It is similar to Arthur 71 in maturity, plant height, and lodging resistance. Oasis is resistant to leaf rust, powdery mildew, loose smut, Hessian fly, and soil-borne mosaic. It has good resistance to Septoria leaf blotch. It is susceptible to stem rust.

**Logan** was developed by Ohio State University and released in 1968. Logan matures 5 to 6 days later than Abe and Arthur and grows 4 to 5 inches taller. Its resistance to lodging is very good. Logan is resistant to soil-borne mosaic, moderately resistant to leaf rust and loose smut, and susceptible to stem rust.

**Blueboy** is a very short, stiff-strawed, white chaff beardless variety developed at North Carolina State University. It matures 7 to 8 days later than Monon and Benhur, weighs 3 to 4 pounds less per bushel than they do, and is susceptible to the rusts and Hessian fly. Blueboy overwintered in 1968-69 and 1969-70 without noticeable cold damage. It was damaged at Urbana during the 1970-71 winter and severely damaged at DeKalb that year. It is apparently more winter hardy than most varieties developed for the southeastern United States, but may be damaged under severe winter conditions in Illinois.

**Blueboy II** is similar to Blueboy in maturity, winter hardiness, plant height, and lodging resistance, and superior in weight per bushel and in leaf rust resistance.

Table 21. — 1975 Wheat Variety Demonstration Yields, Soft Wheat Varieties

| County | Abe | | Arthur | | Arthur 71 | | Blueboy II | | Oasis | | Stoddard | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. |
| Hamilton | 45 | .. | 46 | .. | 42 | .. | 56 | .. | 48 | .. | .. | .. |
| Williamson | 53 | 58 | 69 | 59 | 61 | 60 | 65 | 58 | 56 | 58 | 64 | 60 |
| Jackson | 54 | 59 | 57 | 58 | 58 | 59 | 61 | 55 | 53 | 57 | 55 | 58 |
| White #1 | 40 | 57 | 43 | 60 | 42 | 59 | 37 | 54 | 40 | 57 | 35 | 51 |
| White #2 | 44 | 57 | 39 | 57 | 35 | 57 | 42 | 58 | 41 | 57 | 31 | 56 |
| Lawrence | 35 | .. | 58 | .. | 53 | .. | 51 | .. | 50 | .. | 48 | .. |
| Monroe | 63 | 59 | 71 | 59 | 63 | 59 | 72 | 56 | 65 | 59 | 57 | 58 |
| Henderson | 42 | 58 | 30 | 60 | 44 | 61 | 39 | 60 | .. | .. | 43 | 60 |
| St. Clair #1 | 65 | 58 | 44 | 57 | 54 | 58 | 74 | 55 | 60 | 58 | 53 | 57 |
| St. Clair #2 | 69 | 61 | 69 | 61 | 69 | 62 | 81 | 57 | 67 | 61 | 69 | 61 |
| Randolph | 62 | 59 | 63 | 59 | 65 | 59 | 64 | 56 | 60 | 59 | 56 | 58 |
| Gallatin | 48 | 54 | 40 | 54 | 49 | 53 | 45 | 54 | 48 | 54 | 55 | 52 |
| Madison | 62 | 58 | 61 | 60 | 61 | 59 | 68 | 57 | 65 | 60 | 57 | 60 |
| Stephenson | 66 | 59 | 61 | 57 | 58 | 58 | 52 | 55 | 66 | 60 | 54 | 56 |
| DeKalb | 51 | 59 | 42 | 58 | 42 | 59 | 43 | 49 | 50 | 56 | 51 | 57 |
| Franklin | 58 | .. | 45 | .. | 50 | .. | 54 | .. | 52 | .. | 44 | .. |
| Warren | 79 | .. | 76 | .. | 76 | .. | 77 | .. | 76 | .. | 73 | .. |
| Shelby | 60 | 60 | 69 | 62 | 63 | 60 | 73 | 54 | 61 | 60 | 67 | 60 |
| Average | 57 | 58 | 57 | 58 | 56 | 59 | 60 | 56 | 57 | 58 | 54 | 57 |

**Timwin** is a soft red winter wheat variety released by the University of Wisconsin. It is a bearded white chaff variety which is very winter hardy. It is short-strawed, moderately resistant to lodging, and matures 3 to 5 days later than Monon. It has good tolerance to the rusts, but is susceptible to loose smut and Hessian fly.

**Stoddard** was developed at the University of Missouri and released in 1973. Stoddard is about two days later than Arthur in maturity and 3 to 4 inches taller. It is comparable to Arthur in lodging resistance. It has good resistance to leaf rust, is moderately susceptible to soil-borne mosaic, and is susceptible to stem rust, Hessian fly, and Septoria.

## Varieties: Hard Red Spring

**Pembina,** released in Canada, is an early variety. It is beardless, has white chaff, and is rust resistant.

**Chris** is a beardless hard red spring wheat of medium height and maturity with moderately stiff straw. It is resistant to prevalent races of stem rust, leaf rust, and black chaff. It has good test weight and satisfactory milling and baking qualities. It was released by Minnesota in 1965.

**Crim,** released in Minnesota in 1963, is resistant to stem rust, but susceptible to leaf rust and loose smut. Its grain quality is satisfactory.

**Era** is a semi-dwarf hard red spring wheat variety released by Minnesota in 1971. It is resistant to stem rust, leaf rust, black chaff, and bunt.

**Fletcher** is a semi-dwarf hard red spring wheat released by Minnesota in 1970. It is resistant to stem rust, leaf rust, black chaff, and bunt.

**Polk,** released by the University of Minnesota in 1968, is a bearded variety of medium height and maturity. It has a moderately stiff straw, and good resistance to the common races of leaf and stem rust and to black chaff and bunt. Test weight is excellent.

**Table 22. — Hard Red Spring Wheat Variety Yields, DeKalb**

| Variety | 1975 | | 1974-75 | |
|---|---|---|---|---|
| | Bu./A. | T.W. | Bu./A. | T.W. |
| Era | 23 | 59 | 35 | 55 |
| Fletcher | 21 | 58 | 31 | 54 |
| Polk | 21 | 62 | 30 | 61 |
| Selkirk | 23 | 57 | 28 | 52 |
| Waldron | 26 | 58 | 33 | 52 |
| Ellar | 26 | 60 | 30 | 54 |
| Olaf | 27 | 61 | 34 | 55 |
| Tioga | 23 | 60 | 31 | 56 |

# GRAIN SORGHUM

While grain sorghum can be successfully grown throughout Illinois, its greatest potential is in the southern third of the state. It is adapted to almost all soils, from sand to heavy clay. Its greatest advantage over corn is tolerance of moisture extremes. Grain sorghum usually yields more than corn when moisture is a problem, though it seldom yields as much as corn under optimum conditions.

**Fertilization.** Fertility requirements for sorghum are similar to those of corn. Since the response to nitrogen has been erratic, maximum rate of nitrogen suggested is about 125 pounds. Sorghum is sensitive to salt, and seeds should not be placed in direct contact with starter fertilizer.

**Planting.** Sorghum should not be planted until soil temperature is 65° F. or above. In the southern half of the state mid-May is considered the starting date, and late May to June 1 in the northern half.

Sorghum emerges more slowly than corn and requires a relatively fine and firm seedbed. Planting depth should not exceed 1½ inches, and ¾ to 1 inch is considered best.

**Population and row spacing.** Row spacing experiments have shown that 20- to 30-inch rows produce far better than 40-inch rows. Narrow rows are suggested if weeds can be controlled without mechanical cultivation. Four to 6 plants per foot of row in 30-inch rows at harvest, and 2 to 4 plants per foot in 20-inch rows are adequate. Plant 30 to 50 percent more seeds per foot of row than the intended stand.

**Weed control.** Since emergence of sorghum is slow, controlling weeds presents special problems. Suggestions for chemical control of weeds are given in the back of this handbook. As with corn, a rotary hoe is useful before weeds become permanently established.

**Harvesting and storage.** Timely harvest is important. Rainy weather after sorghum grain reaches physiological maturity may cause sprouting in the head or weathering (soft and mealy grain), or both.

**Marketing.** Before planting, check on local markets. Because of limited acreage in Illinois, many elevators do not purchase grain sorghum.

**Grazing.** After harvest, sorghum stubble can be used for pasture. Livestock should not be allowed to graze for 1 week after frost, since the danger of prussic acid or HCN poisoning is especially high. Newly frosted plants sometimes develop tillers high in prussic acid.

# OATS

Spring oats are a cool weather crop. Cool weather is especially important during the kernel filling stage. Therefore early planting is important for top yield. They should be planted as soon as you can get the land ready.

Oats respond to a good seedbed. Where they follow corn plowing is best. But if this is impractical, better oat yields will result if the stalks are shredded before disking.

Illinois tests show a 7- to 10-bushel advantage for drilling as compared with broadcasting. The normal seeding rate when planted by drilling is 2 to 2½ bushels per acre.

## Varieties of Spring Oats

Brave is a high-yielding variety from Illinois. It has excellent smut resistance, some tolerance to septoria, and tolerance to barley yellow dwarf virus. Its test weight is adequate, quality good, and seed color yellow. Brave has fair straw strength but is not quite equal to Newton in this respect. Generally an early variety, Brave appears to be well adapted throughout Illinois.

Chief, released by the South Dakota Agricultural Station in 1972, matures at the same time as Garland. Grain color is yellow with about 2 percent of the kernels being white. It grows about 2 inches taller than Garland, but is comparable in lodging resistance and kernel weight. It is resistant to leaf rust.

**Clintford** was developed at Purdue from the cross of a Clintland type with Milford. Milford was introduced from Wales for its excellent straw strength. Clintford is the first variety in the United States to use this source of straw strength. The grain is a light brownish white (or light yellowish white in some seasons), large, plump, and very high in test weight. Clintford has very short, stiff straw with large-diameter stems. It matures about 2 days earlier than Clintland 64. Clintford has a compact panicle that distinguishes it from other varieties grown in Illinois.

**Clintland 64** was released by the Indiana Agricultural Experiment Station and is very similar to Clintland 60, except for improved leaf-rust resistance. Clintland 64 is one of the most leaf-rust-resistant varieties currently available. The variety is not resistant to barley yellow dwarf virus.

**Dal**, released by the Wisconsin Agricultural Experiment Station in 1972, is comparable to Froker in height and maturity. It is resistant to the rusts and smut. Straw strength is about equal to Froker. Dal kernels, which have a whitish color, contain about 2.5 percent more protein than other commonly grown varieties.

Diana is a yellow oat released by Purdue University in 1966. It matures about the same time as Garland, yields above Clintland 64, and possesses good test weight and straw strength. Diana is medium in height, has good resistance to leaf rusts, and is resistant to most races of stem rust.

**Froker** is a yellow oat released by the University of Wisconsin in 1970. It is late maturing, similar to Lodi. Froker has improved leaf rust resistance, resistance to most races of stem rust, and good resistance to smut. Straw height is similar to Portal but with greater strength.

**Garland**, released by Wisconsin, performs very well in northern and central Illinois. A sister selection of Dodge and Goodfield, Garland has shown good performance in Urbana and DeKalb trials and in county demonstrations. It has good test weight, stands well, and has resistance to some races of smut.

**Goodland**, released by Wisconsin in 1974, is comparable to Garland in maturity. It grows to about the same height as Otter and has excellent resistance to lodging. Goodland is moderately resistant to stem rust, resistant to leaf rust, and susceptible to Barley Yellow Dwarf. Like Dal and Otee it has high protein content.

Grundy is a yellow oat variety released by the Iowa Agricultural Experiment Station in 1972. It is similar to Jaycee in maturity, lodging resistance, and plant height. It is resistant to some but not all races of leaf rust. It is susceptible to stem rust and barley yellow dwarf virus.

**Holden** was released by the Wisconsin Agricultural Experiment Station in 1967. The variety matures slightly later than Garland. Its yield has been 5 to 8 percent greater per acre than Garland in northern Illinois, but slightly below Garland in central and south-central Illinois. The grain of Holden has a yellow hull, a well-filled kernel, and a good test weight that is equal to Garland. Holden is resistant to older races of leaf rust and intermediate-to-susceptible to newer races. It has resistance to smut and some races of stem rust.

Jaycee is an early maturing, high-yielding variety developed at the University of Illinois. The grain color is light brownish to yellowish white. It produces fairly large, plump kernels with groat percentage and test weight similar to Newton. Jaycee is very short strawed (1 to 3 inches shorter than Goodfield), and has stood well under Illinois conditions until maturity. Jaycee loses its strength rapidly after maturity. Harvest Jaycee as soon after maturity as is possible to avoid high field losses. It has barely yellow dwarf virus tolerance that is superior to any variety now available for growing in Illinois. It is resistant to some, but not all, races of leaf and stem rust. Jaycee is resistant to races of smut that have occurred in Illinois.

**Kota** was developed by South Dakota State University. It is similar to Portal in height, heading date, matu-

**Table 23. — 1975 Spring Oat Variety Demonstration Yields**

| Variety | | Ogle County | Mercer County | Warren County | Winnebago County |
|---|---|---|---|---|---|
| Clintford | Bu./A. | 100.5 | .. | .. | .. |
| | T.W. | 35 | .. | .. | .. |
| Clintland 64 | Bu./A. | .. | 52.5 | 53.8 | 73.7 |
| | T.W. | .. | .. | 31 | 31 |
| Dal | Bu./A. | 67.0 | 60.4 | 48.0 | 63.1 |
| | T.W. | 28 | .. | 30 | 31 |
| Froker | Bu./A. | 84.4 | 66.7 | 50.4 | 81.4 |
| | T.W. | 30 | .. | 31 | 33 |
| Garland | Bu./A. | 97.6 | 58.0 | 51.7 | 84.4 |
| | T.W. | 32 | .. | 30 | 33 |
| Goodland | Bu./A. | 85.8 | 54.0 | 41.8 | 88.9 |
| | T.W. | 32 | .. | 29 | 32 |
| Grundy | Bu./A. | .. | .. | .. | 74.5 |
| | T.W. | .. | .. | .. | 31 |
| Holden | Bu./A. | 81.5 | .. | .. | 76.8 |
| | T.W. | 31 | .. | .. | 30 |
| Jaycee | Bu./A. | .. | 69.3 | 56.3 | .. |
| | T.W. | .. | .. | 30 | .. |
| Noble | Bu./A. | 97.6 | 74.7 | 55.7 | 84.4 |
| | T.W. | 30 | .. | 29 | 32 |
| Otee | Bu./A. | .. | 56.0 | 58.8 | 81.3 |
| | T.W. | .. | .. | 29 | 32 |
| Otter | Bu./A. | 84.4 | .. | .. | .. |
| | T.W. | 28 | .. | .. | .. |
| Portal | Bu./A. | 94.9 | .. | .. | .. |
| | T.W. | 31 | .. | .. | .. |
| Stout | Bu./A. | 93.4 | 52.5 | 52.5 | 89.7 |
| | T.W. | 30 | .. | 30 | 31 |
| Wright | Bu./A. | 82.2 | 82.0 | 55.7 | .. |
| | T.W. | 31 | .. | 31 | .. |

rity date, test weight, and kernel size. It is moderately resistant to lodging and to stem and crown rust. It is resistant to smut and has some tolerance to the barley yellow dwarf virus.

**Newton** was released by Indiana in 1955. This variety has both Nemaha and Clinton in its parentage, and combines the best characteristics of each. Generally, it has large, plump kernels and good straw strength. Newton shows some tolerance to barley yellow dwarf virus and has some rust resistance, but it is susceptible to several of the newer races of rust. It is also susceptible to septoria.

**Noble** was released to certified seed producers for planting in 1974. It was developed by the Purdue University Agricultural Experiment Station and the Agriculture Research Service, USDA. Noble is an improved Tippecanoe type. It is resistant to races of loose smut currently prevalent in Illinois and is moderately resistant to barley yellow dwarf. It has limited resistance to the rusts, being susceptible to current predominant races. Performance tests have shown it to have excellent yielding ability, resistance to lodging, and good test weight.

**Orbit** is a white oat released from Cornell University. It is short-strawed, lodging resistant, and matures three to five days later than Newton. It is resistant to smut, stem rusts, and some of the leaf rusts. Orbit has about the thickest hull among current varieties. The heavy hulls lower the groat-to-hull percentage.

**Otee** is a variety developed in Illinois and released jointly by the Illinois Agricultural Experiment Station and the USDA for planting by certified seed producers in 1973. Otee is the result of a cross of Albion x Newton 2 x Minhafer 3 x Jaycee. The final selection was made in the fifth generation following the final cross. Yields have been similar to the Jaycee variety in Illinois, but its yields have been somewhat superior to Jaycee in regional uniform trials. The grain of Otee is higher in percent protein than other varieties currently grown in Illinois. Otee is early in maturity, has short straw, and good lodg-

**Table 24. — University of Illinois Oat Variety Yields**

| Variety | DeKalb | | | | Urbana | | | |
|---|---|---|---|---|---|---|---|---|
| | 1975 | | 1974-75 | | 1975 | | 1974-75 | |
| | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. |
| Allen | 87.4 | 30 | .. | .. | 115.8 | 29 | .. | .. |
| Chief | 88.3 | 27 | 84 | 31 | 110.5 | 28 | 94 | 29 |
| Clintford | 80.6 | 31 | 71 | 33 | 115.3 | 31 | 93 | 32 |
| Clintland 64 | 89.3 | 29 | 83 | 32 | 112.0 | 29 | 94 | 33 |
| Dal | 83.6 | 26 | 79 | 30 | 93.8 | 28 | 88 | 29 |
| Froker | 89.7 | 26 | 82 | 30 | 118.6 | 27 | 98 | 28 |
| Garland | 86.7 | 30 | 82 | 33 | 113.8 | 29 | 98 | 30 |
| Goodland | 81.6 | 27 | 76 | 31 | 88.7 | 28 | 82 | 29 |
| Grundy | 79.6 | 33 | 74 | 34 | 113.3 | 29 | 95 | 30 |
| Holden | 86.8 | 28 | 82 | 32 | 105.3 | 27 | 90 | 28 |
| Jaycee | 71.9 | 28 | 69 | 31 | 123.3 | 31 | 105 | 30 |
| Newton | 82.1 | 27 | 74 | 31 | 95.9 | 28 | 86 | 29 |
| Noble | 84.0 | 25 | 83 | 30 | 126.6 | 29 | 109 | 29 |
| Orbit | 81.3 | 24 | 85 | 28 | 118.0 | 27 | 109 | 28 |
| Otee | 77.4 | 29 | 78 | 31 | 115.5 | 30 | 104 | 30 |
| Otter | 92.2 | 26 | 87 | 29 | 130.0 | 27 | 114 | 28 |
| Spear | 97.3 | 28 | .. | .. | 117.9 | 28 | .. | .. |
| Stout | 82.8 | 29 | 80 | 32 | 104.6 | 27 | 95 | 28 |
| Wright | 84.2 | 28 | .. | .. | 108.3 | 30 | .. | .. |

ing resistance. It is definitely superior to Jaycee in after-ripening standability. Otee is resistant to many of the races of leaf and stem rust and has good resistance to barley yellow dwarf disease.

**Otter** is a white oat released by the University of Minnesota in 1970. It matures about the same time as Garland and is of similar height. Straw strength is good. Otter is resistant to smut. It has fair to good resistance to leaf and stem rusts. The yields of Otter have been high and its test weight slightly below most varieties, but the groat percentage has been high.

**Portal** was released by the Wisconsin Agricultural Experiment Station in 1967, and is a variety that matures in midseason in Illinois. Portal is similar to Garland in most characteristics but has yielded 5 to 10 percent more than Garland. The test weight and straw strength of Portal are slightly less than Garland. It is taller than Garland and matures a little later than Garland. The variety has a yellow hull and resistance to smut and most races of stem rust. Portal has more resistance to leaf rust than most varieties available at present, equaling Clintland 64.

**Stout** was released to certified seed producers for planting in 1974. It was developed by the Purdue University Agricultural Experiment Station and the Agriculture Research Service, USDA. Stout is a short, stiff-strawed variety with a compact panicle that grows about 2 inches shorter than Jaycee. It is resistant to stem rust and smut, moderately resistant to leaf rust, and has some tolerance to barley yellow dwarf.

### Winter Oats

Winter oats are not as winter hardy as wheat and are adapted to only the southern one-third or one-quarter of the state. U.S. Highway 50 is about the northern limit for winter oats.

Since the crop is somewhat winter tender and is not attacked by Hessian fly, planting in early September is highly desirable. Experience has shown that oats planted before September 15 are more likely to survive the winter than those planted after September 15.

The same type of seedbed is needed for winter oats as for winter wheat. The fertility program should be comparable to that for spring oats. Seeding rate is 2 to 3 bushels per acre when drilled.

## TRITICALE

Triticale is a new crop resulting from the crossing of wheat and rye. The crop is still in the developmental stage. The varieties currently available are usually deficient in some characteristic such as winter hardiness, poor seed set, or shriveled seed. In addition, they are of feed quality only. They do not possess the milling and baking qualities needed for use in human food.

The potential exists, however, for plant breeders to correct these deficiencies. When this is done the crop may be especially valuable for its high protein content and high protein quality.

A limited testing program on the Agronomy South Farm and the Northern Illinois Experiment Field in DeKalb County indicates that the crop is generally lower yielding than winter wheat and spring oats. There are both spring and winter types of triticale available.

# BARLEY

Both spring and winter barley may be grown in Illinois. Spring barley is best adapted to the northern one-quarter or one-third of Illinois, but it has been grown successfully as far south as Champaign County. Winter barley has been grown as far north as Will County, but is best adapted to the southern half of the state.

Plant spring barley early or about the same time as spring oats at 1½ to 2 bushels per acre. Harvest the crop as soon as it is ripe because of the danger of excessive lodging. Fertility requirements are essentially the same as for spring oats.

Winter barley is not as winter hardy as the commonly grown varieties of winter wheat. For this reason winter barley should be planted about 10 days to two weeks earlier than wheat. Sow with a drill and plant at the rate of 2 bushels of seed per acre.

The fertility requirements for winter barley are similar to those for winter wheat with the exception that less nitrogen will be required. Most winter barley varieties are less resistant to lodging than wheat varieties. Winter barley cannot stand "wet feet," therefore should not be planted on land that tends to be low and wet.

Watch out for army worms and chinch bugs. Both prefer barley to almost any other crop.

Table 25. — Spring Barley Performance at DeKalb

| Variety | 1975 | | 1974-75 | |
|---|---|---|---|---|
| | Bu./A. | T.W. | Bu./A. | T.W. |
| Beacon | 42 | 40 | 40 | 41 |
| Bonanza | 46 | 45 | 42 | 43 |
| Burk | 43 | 48 | 40 | 46 |
| Conquest | 38 | 43 | 43 | 41 |
| Dickson | 37 | 44 | 38 | 43 |
| Larker | 40 | 47 | 45 | 45 |

## Spring Varieties

**Larker** is the most popular spring barley variety in Minnesota, Wisconsin, and Iowa. It has yielded well in Illinois. It is an approved malting variety. It has good straw strength and kernel plumpness.

Other varieties that are grown for malting purposes in the spring barley region include those in the spring barley variety test, except for Burk.

**Burk** is a six-row, smooth-awn variety developed at the University of Wisconsin. It is a non-malting variety.

## Winter Varieties

**Paoli** is a new six-row winter barley from Purdue University. It is early maturing, very winter hardy, short and stiff strawed, and has short rough awns that are persistent, making is moderately difficult to thresh. The earliness of Paoli may be helpful for double-cropping programs. It was very high yielding in the 1971 trial at Brownstown.

**Barsoy** is an early winter barley from the Kentucky Agricultural Experiment Station. It has a good yield record. The earliness of Barsoy allows it to fit well into a double-cropping program.

Table 26. — Winter Barley Performance at Urbana and Brownstown

| Variety[a] | Urbana | | | | Brownstown | | | |
|---|---|---|---|---|---|---|---|---|
| | 1975 | | 1974-75 | | 1975 | | 1974-75 | |
| | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W. | Bu./A. | T.W |
| Barsoy | 80 | 47 | 69 | 42 | 60 | 46 | 49 | 45 |
| Paoli | 100 | 48 | 70 | 40 | 68 | 43 | 60 | 43 |
| Harrison | 87 | 49 | 64 | 44 | 70 | 45 | 64 | 45 |
| Lakeland | 99 | 48 | 68 | 42 | 82 | 45 | 72 | 45 |
| Schuyler | 94 | 46 | 66 | 40 | 42 | 40 | 43 | 41 |

[a] Listed from earliest to latest.

## CROPS FOR LATE PLANTING

In most years flooding or some other disaster makes replanting of corn and soybeans necessary somewhere in Illinois.

When this happens the most common questions are: Is it too late to replant with corn or soybeans? If it is not too late, how early a variety should be used? If it is too late for corn or soybeans is there any other crop that can be substituted for feed grain or cash-grain production.

Any answer to these questions assumes that (1) weather conditions following replanting will favor immediate germination and emergence, (2) that rainfall and temperatures will favor normal growth and development, and (3) that the first killing frost in the fall will be as late or later than average.

The following are estimates of how late corn and soybeans may be planted in Illinois when favorable weather and growing conditions follow replanting.

Starting in the northwestern corner of the state where the first killing frost can be expected before October 5, June 15 is the latest date that early varieties of corn can be planted with reasonable assurance that they will be mature (30 to 35 percent moisture) before the first frost. Make the shift to early varieties in late May.

As the average date of the first killing frost moves later into October the latest date for planting corn for grain moves later into June.

In the northern third of the state you can move the planting date later into June about the same number of days that the first frost falls after October 5.

In the southern two-thirds of the state (this is especially true of the southern one-third) you can move the planting date proportionally later into June because of the higher temperatures during the remainder of the growing season. In central Illinois where the average killing frost occurs on October 15, early varieties of corn planted as late as July 5 has a 50-percent chance of maturing before frost.

Unless the need for grain or silage is especially great, planting corn later than July 5 to 10 is of questionable merit because yields are likely to be low.

Soybeans have the ability to greatly shorten their vegetative period and may be planted later than corn with reasonable assurance that they will mature before frost. In northern Illinois, where the first killing frost is expected about October 5, early varieties such as *Chippewa 64* and *Hark* may be expected to mature when planted as late as the last of June. The later varieties, such as Harosoy 63 and Corsoy, may be used until the middle of June.

In north central Illinois you can plant *Harosoy 63* and *Corsoy* until early July and you can use varieties of the maturity of Amsoy until mid-June.

In central Illinois Wayne and varieties of similar maturity will mature when planted by mid-June. Use *Amsoy, Harosoy 63,* and *Corsoy* until July 5 to 10.

The growing season in southern Illinois is long enough that most of the varieties normally grown in the area will mature when planted as late as July 5 to 10.

When you must plant soybeans late, use the tallest variety that has a reasonable chance to mature. One of the problems with late-planted soybeans is short plant height and low podding. Dry weather aggravates this.

Other grain crops that mature in a short time and may be used in an emergency are sorghum and buckwheat.

Varieties of sorghum that will mature in 90 to 100 days are sometimes used for late planting. The penalty for planting sorghum late is often not so great as it is for corn and other crops. If the crop is being grown as a cash crop, arrangements for a market should be made ahead of planting. Some elevators prefer not to handle sorghum. Local livestock feeders or feed mills may be interested in the crop.

Another problem usually associated with sorghum is that of drying the grain. Harvest the grain as soon as it is mature. Often this will be before the plant is dry and the grain will be too wet to store without drying.

Buckwheat may mature in 75 to 90 days. It can be planted as late as July 10 to 15 in the northern part of the state and late July in southern Illinois.

The crop is sensitive to both cold and hot weather. It will be killed by the first frost in the fall. Yields will be disappointingly low if it blooms during hot weather.

The market for buckwheat is limited unless you plan to use it for livestock feed. Be sure of a market before you plant it.

## High Yields

Thick, vigorous stands of grasses and legumes are needed for high yields. A thick stand of grass will cover nearly all the ground. A thick stand of alfalfa is about 30 plants per square foot the seeding year, 10 plants per square foot the second year and 5 plants per square foot for succeeding years.

Vigorous stands are obtained and maintained by adequate fertilization, selection of disease-resistant and insect-resistant varieties, selection of varieties exhibiting rapid growth and recovery growth, timely harvesting and protection of the stand from insects.

## Establishment

**Spring seeding date** for hay and pasture species in Illinois is late March or early April as soon as a seedbed can be prepared. An exception is when seedings are made in a winter-sown companion crop. In winter companion crops, hay and pasture species should be seeded about the time of the last snow.

Spring seedings in oats should be done at the time the oats are seeded.

Spring seedings are more successful in the northern half of Illinois than in the southern half. The frequency of success in the southern one-quarter to one-third of the state indicates late-summer seedings may be more desirable than spring seedings. Spring seedings are usually more successful than late-summer seedings in the northern one-quarter of Illinois.

**Late-summer seeding date** is August 10 in the northern one-fourth of Illinois, August 30 in central Illinois, and September 15 in the southern quarter of Illinois. Seedings should be made close to these dates and not more than five days later to assure that the plants become well established before winter.

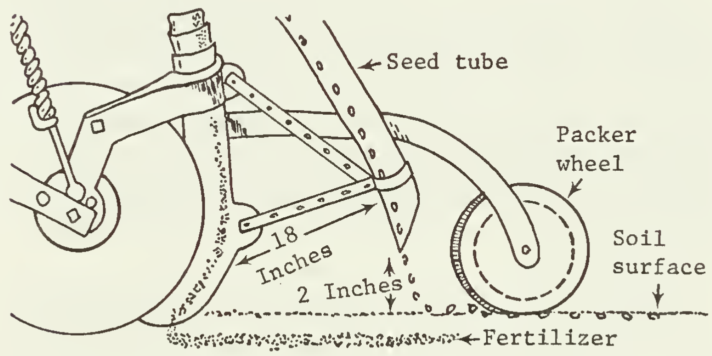
**Seeding rates** for hay and pasture mixtures are shown in Table 35 on page 29. These rates are for average conditions and when seeded with a companion crop in the spring or without a companion crop in late summer. Higher rates can be used to obtain high-yields from alfalfa seeded without a companion crop in the spring. Higher seeding rates than described in Table 38 have proven economical in northern and central Illinois when alfalfa was seeded as a pure stand in early spring and two or three seeding-year harvests taken. Seeding at 18 pounds of alfalfa per acre has produced 0.2 to 0.4 ton higher yield than seedings at 12 pounds per acre in northern and central Illinois, but not in south central Illinois (Table 27).

**Seeding methods,** either broadcast or band seeding, are most successful when weeds are destroyed, crop residues are incorporated, the soil is firmed before and after seeding, and the soil is fertile or properly fertilized. Broadcast seedings are as successful and high yielding as band seedings when soils are fertile and seeding conditions good. Band seeding may have some advantage over broadcast seedings on low-fertility soils and where crusting soils are a problem. Band seeding is placing a high-phosphate fertilizer 1½ to 2 inches deep in the soil with a grain drill and placing the forage seeds on the soil surface through a flexible tube from the seed box, dropping the seed about 18 inches behind the disk opener of the drill (Fig. 2).

**Table 27. — Accumulated Dry-Matter Yields of Alfalfa Seeded Alone in the Spring Over 2-, 3-, and 4-Year Periods at Three Locations, 1967-70**

| Seeding rate (lb. per acre) | Brownstown (2 years) | Urbana (4 years) | DeKalb (3 years) |
|---|---|---|---|
| | *Tons per acre* | | |
| 12 | 6.73 | 19.22 | 13.20 |
| 18 | 6.81 | 19.64 | 13.57 |
| 24 | 6.49 | 19.69 | 13.53 |

Forage crop seeds are small and should be seeded no deeper than one-fourth to one-half inch. These seeds need to be in close contact with soil particles. Firming the seedbed with a corrugated roller before seeding and rolling the seed into contact with the soil with a corrugated roller or press wheel after seeding is the best known method of seeding forages.




**Placement of high-phosphate fertilizer with grain drill. (Fig. 2)**

## Fertilizing and Liming Before or at Seeding

**Lime.** Apply lime at rates suggested in Figure 6, page 33. If rate requirements are in excess of 5 tons, apply half before the primary tillage (in most cases, plowing) and half before the secondary tillage (harrowing, disking). Apply rates of less than 5 tons at one time, preferably after plowing, but either before or after is acceptable.

**Nitrogen.** No nitrogen is suggested for legume seedings on soils above 2.5 percent organic matter. Up to 20 pounds per acre may help assure rapid seedling growth of legume-grass mixtures on soils with less than 2.5 percent organic matter. If seeding a pure grass stand, 50 to 100 pounds per acre in the seedbed is suggested. If band seeding, apply nitrogen with phosphorus through the grain drill. For broadcast seedings, apply broadcast with phosphorus and potassium.

**Phosphorus.** Apply all phosphorus at seeding time (Tables 46 and 48) or broadcast part of it with potassium. For band seeding reserve a minimum of 30 pounds of $P_2O_5$ per acre. For broadcast seeding, broadcast all the phosphorus with potassium preferably after primary tillage and before final seedbed preparation.

**Potassium.** Broadcast application of potassium is preferred (Tables 47 and 48). For band seeding, you may safely apply a maximum of 30 to 40 pounds $K_2O$ per acre in the band with phosphorus. The response to band fertilizer will be mainly from phosphorus unless the K soil test is very low (perhaps 100 or less). For broadcast seeding, apply all the potassium after the primary tillage. You can apply up to 300 pounds of $K_2O$ per acre in the seedbed without damaging seedlings.

## Fertilization

**Nitrogen.** See pages 37 and 38.

**Phosphorus.** This nutrient may be applied in large amounts, adequate for two to four years. The annual needs of a hay or pasture crop are determined from yield and nutrient content of the forage harvested (Table 48). Grasses, legumes, and grass-legume mixtures contain about 12 pounds of $P_2O_5$ (4.8 pounds of P) per ton of dry matter. Total annual fertilization needs include any needed build-up rate (Table 46) and the maintenance rate (Table 48).

**Potassium.** Potassium is needed in large amounts by grasses to balance high rates of nitrogen fertilization. As nitrogen rates increase, the percent nitrogen in the plant tissue also increases. All the nitrogen applied to grasses may not be converted to protein and may remain as nonprotein nitrogen in the plant if potassium is deficient. Potassium helps the plant convert nitrogen to protein.

Legumes feed heavily on potassium. Potassium is a key element in maintenance of legumes in grass-legume stands and is also credited with improving winter survival.

Annual potassium needs are determined from yield, nutrient content in the forage that is harvested, and nutrient build-up requirements of a particular soil (Tables 47 and 48). Grasses, legumes, and grass-legume mixtures contain about 50 pounds of $K_2O$ (41.5 pounds of K) per ton of dry matter.

**Boron.** Boron deficiency symptoms appear on second and third cuttings of alfalfa during drouth periods in some areas of Illinois. But yield increases from boron fertilization have been infrequent. There is no recommendation for general application of boron in Illinois. If you suspect there is a boron deficiency, topdress strips in your alfalfa fields with 30 pounds per acre of household borax (3.3 pounds of actual boron).

## Management

**Seeding year.** Spring-seeded hay crops and pastures in a companion crop will benefit by early removal of the companion crop. Oats, wheat, or barley should be removed when the grain is in the milk stage. If these small grains are harvested for grain, it is important to remove the straw and stubble as soon as possible. As small grain yields increase, greater competition is being expressed on underseeded legumes and grasses and fewer satisfactory stands are being established by the companion crop method. Forage seedings established with a companion crop may have one harvest taken by late August in northern Illinois, and occasionally two harvests by September 10 in central Illinois, and by September 25 in southern Illinois.

Spring-seeded hay crops and pastures without a companion crop should be ready for harvest 65 to 70 days after an early April seeding. Weeds will very likely need to be controlled about 30 days after seeding unless a preemergence herbicide was used. A postemergence herbicide, 4-2,4-DB, is effective against most broad-leaved weeds. Leafhoppers often become a problem between 30 and 45 days after an early April seeding and will need to be controlled to obtain a vigorous high-yielding stand.

Second and third harvests may follow the first harvest at 35- to 40-day intervals. The last harvest of the season should be in late August for the northern quarter of Illinois, by September 10 for the central section, and by September 20 for the southern quarter of Illinois.

**Established stands.** Maximum dry-matter yield from alfalfa and most forages is obtained by harvesting or grazing the first cutting at nearly full bloom and each succeeding harvest every 40 to 42 days thereafter until September. This management produces a forage that is relatively low in digestibility. It is suitable for livestock on maintenance, will produce slow weight gain, and can

Table 28. — Acceptable Fall Harvesting Dates for Alfalfa in Illinois by Region

| | Northern Illinois | Central Illinois | Southern Illinois |
|---|---|---|---|
| Normal last date | Sept. 1 | Sept. 10 | Sept. 20 |
| Optional last date | None | Oct. 25 | Oct. 30 |

be used in low-production feeding programs. High performance feeding programs need a highly digestible forage. The optimum compromise between high digestibility and dry-matter yield of alfalfa is to harvest or graze the first cutting at the late-bud-to-first flower stage and to make subsequent cuttings or grazings at 35-day intervals. Rotational grazing is essential to maintain legumes in pastures. A rotational grazing program should provide for 5 to 7 days of grazing and 30 to 35 days of rest.

Winter survival and vigor of spring growth are greatly affected by the time of the fall harvest. A high level of root reserves (sugars and starches) is needed. Root reserves decline following a harvest as new growth begins. About three weeks after harvesting, root reserves are depleted to a low level and the top growth is adequate for the photosynthesis to support the plant's needs for sugars. Root reserves are replenished gradually from this point until harvested or until the plant becomes dormant in early winter. Harvests made in September and October affect late-fall root reserves of alfalfa more than do harvests made in the summer. A recovery growth period from early September to late October is needed to store a high level of root reserves. A harvest may be taken late in October after the plants are dormant in central and southern Illinois on well-drained soils. See Table 28 for fall management suggestions.

## Species

**Alfalfa** is the highest yielding perennial forage crop suited to Illinois, and its nutritional qualities are nearly unsurpassed. Alfalfa is an excellent hay crop species and can be used in pastures with proper management as mentioned above.

Bloat in ruminant animals is often associated with alfalfa pastures. Balanced soil fertility, including grasses in mixtures with alfalfa, maintaining animals at good nutritional levels, and using bloat-inhibiting feed amendments are methods to reduce or essentially eliminate the bloat hazard.

Many varieties of alfalfa are available. An extensive testing program has been underway in Illinois for many years. A summary of variety performance is presented in Table 29. Bacterial wilt resistance is usually necessary if alfalfa is to persist in most Illinois fields beyond 2 or 3 years. Moderate resistance to bacterial wilt enables alfalfa to persist up to 4 or 5 years. Susceptible varieties usually decline in a stand severely in the third year of production and may die out in the second year under intensive harvesting schedules.

Other diseases and insects are problems and some varieties have particular resistance to these problems. You should question your seedsman concerning these attributes of the varieties being offered to you.

**Red clover** is the second most important hay and pasture legume in Illinois. It does not have the yield potential of alfalfa under good production conditions, but can persist in more acid conditions and under more shade competition than alfalfa. Although red clover is physiologically a perennial, root and crown diseases limit the life of red clover to two years. The new variety Kenstar has increased resistance to root and crown diseases and is expected to be productive for at least three years.

Red clover does not have as much seedling vigor or as rapid seedling growth rate as alfalfa. Therefore, red clover does not fit into a spring seeding without a companion crop program as well as alfalfa.

There are fewer varieties of red clover than of alfalfa. Mammoth red clover has increased in use during the last two or three years. Yields of mammoth red clover have been lower than most of the improved varieties of medium red clover (Table 30).

**Ladino clover** is an important legume in pastures, but has received little attention recently because of its short-lived character. The very leafy nature of ladino makes it an excellent legume for swine. It is a very high-quality forage for ruminant animals also, but problems of bloat are frequently experienced.

Ladino lacks drouth tolerance because its root system is rarely as deep as red clover or alfalfa.

**Birdsfoot trefoil** has been popular in permanent pastures in northern Illinois. It has a long life, but becomes established very slowly. Seedling growth rate is much slower than alfalfa or red clover.

A root rot has made birdsfoot trefoil a short-lived crop throughout southern Illinois. A recent variety, Dawn, may have adequate resistance to persist throughout the state.

**Crownvetch** is a relatively new legume for Illinois farmers. As a forage crop, crownvetch is much slower in seedling emergence, seedling growth rate, early season growth, and recovery growth than alfalfa or red clover. Growth rate is similar to birdsfoot trefoil. The potential of crownvetch as a hay or pasture plant seems restricted to very rough sites and soils of low productivity.

**Sainfoin** is a legume introduced into western United States from Russia. This species has failed to become well enough established in Illinois tests to make valid comparisons with alfalfa, red clover, and others. Observations indicate sainfoin has a slow growth and recovery growth rate and is not well suited to the humid conditions of Illinois.

**Hairy vetch** is an annual legume that has limited value as a hay or pasture species. Low production and its viny nature have discouraged much use.

**Lespedeza** is a popular annual legume in the southern one-third of Illinois. It comes on strong in mid-summer when most other forage plants are at their low ebb in production. It survives on soils of low productivity and is low yielding. It does not produce as well as a good stand of alfalfa even in mid-summer nor will it encroach on a good alfalfa stand. As alfalfa or other vigorous pasture plants fade out of a pasture, lespedeza may enter.

**Timothy** is the most popular hay and pasture grass in Illinois. Timothy is not as high yielding and has less mid-summer production than smooth bromegrass. There is a limited amount of effort being expended to develop new varieties (Table 31).

**Smooth bromegrass** is probably the most widely adapted, high-yielding grass species for northern and central Illinois. Smooth bromegrass combines well with alfalfa or red clover. It is productive, but has limited summer production when moisture is short and temperatures are high. It produces well in spring and fall and can utilize high-fertility programs. There are a few improved varieties and breeding work continues (Table 32).

**Orchardgrass** is one of the most valuable grasses for hay and pasture use in Illinois. It is adapted throughout the state, being marginally winter hardy for the northern one-fourth of the state. Orchardgrass heads out relatively early in the spring, thus should be combined with early flowering alfalfa varieties. Orchardgrass is one of the more productive grasses in mid-summer. It is a high-yielding species and several varieties are available. Newer varieties are being developed (Table 33).

**Reed canarygrass** is not widely used, but has growth attributes that demand consideration. Reed canarygrass is the most productive of the tall perennial grasses that are well suited to Illinois hay and pasture lands. It tolerates wet soils but also is one of the most drouth-resistant grasses and can utilize high fertility. It is coarser than orchardgrass or bromegrass, but not as coarse as tall fescue. Grazing studies indicate reed canarygrass will produce good gains equal to bromegrass, orchardgrass, or tall fescue under proper grazing management. Reed canarygrass should be considered for grazing during spring, summer, and early fall. Cool temperatures and frost retard the growth and induce dormancy earlier than with tall fescue.

**Tall fescue** is a popular grass for beef cattle in southern Illinois. It is especially useful for winter pasture. Tall fescue is most palatable during spring and late fall. Summer production and palatability are low. Tall fescue is a high-yielding grass, outstanding in performance when used properly. Tall fescue is marginally winter hardy for the northern one-fourth of the state.

**Sudangrass, sudangrass hybrids, and sorghum-sudangrass hybrids** are annual grasses that are very productive in late summer. These grasses need to be seeded each year on a prepared seedbed. The total season production by these grasses may be less than from perennial grasses with equal fertility and management. However, these annual grasses fill a need for quick supplemental pastures as green feed. These tall, juicy grasses are difficult to make into high-quality hay. Sudangrass and sudangrass hybrids have finer stems than the sorghum-sudan hybrids, thus will dry more rapidly and should be chosen for hay purposes over the sorghum-sudan hybrids. Crushing the stems with a hay conditioner will help speed the drying rate.

## Varieties of Hay and Pasture Crops

**Alfalfa.** There are many privately developed varieties available. Private varieties are usually marketed through a few specific dealers. Not all varieties under test or recently tested by the University of Illinois are available in Illinois.

The listing of alfalfa variety performance in Table 29 is summarized by compiling test data information since 1961. Some varieties may have been in test every year since 1961 and others only recently. However, each variety appearing in this list has been in test at least two years.

**Red clover** varieties (Table 30) are mostly from the U.S. Department of Agriculture and state experiment stations. Private breeders are becoming active in red clover variety development.

Other hay and pasture crop varieties and their use and performance are listed in Tables 31, 32, 33, and 34.

## Forage Mixtures

Mixtures (Table 35) of legumes and grasses are usually desired. Yields tend to be greater with mixtures than either the legume or the grass alone. Grasses are desirable additions to legume seedings to fill in where the legume ceases to grow, to reduce the bloat hazard with ruminant

Table 29. — Leading Alfalfa Varieties Tested Two Years or More in Illinois, Given as Percentage of Yield of Check Varieties[a]

| Variety | Bacterial wilt | Nor. Ill. | Cen. Ill. | So. Ill. |
|---|---|---|---|---|
| A-24 | S[b] | 105 | 97 | 90 |
| Agate | R[c] | 102 | 101 | ... |
| Anchor | R | 110 | 101 | 99 |
| ATRA 55 | R | 107 | 104 | ... |
| Cayuga | R | 105 | 104 | 99 |
| Cherokee | S | 103 | 103 | 107 |
| Dominor | R | 107 | 100 | 111 |
| Frank's Langmeiler | S | 97 | 100 | 106 |
| Glacier | S | 97 | 101 | 106 |
| Gladiator | R | 98 | 106 | 100 |
| Haymor | S | 99 | 103 | 106 |
| Lancer | R | 100 | 104 | 106 |
| Milfeuil | S | 93 | 101 | 108 |
| Nugget | R | 98 | 104 | 88 |
| Pacer | R | 114 | 104 | ... |
| Saranac | R | 107 | 104 | 105 |
| Superstan | .. | 104 | 99 | 98 |
| Tempo | R | 110 | 100 | 105 |
| Thor | R | 108 | 100 | 102 |
| Titan | R | 104 | 104 | 101 |
| Valor | R | 103 | 103 | ... |
| Vernal | R | 101 | 100 | 100 |
| Weevlchek | R | 109 | 101 | 102 |
| WL 210 | MR[d] | 110 | 103 | 114 |
| WL 215 | R | 106 | 104 | ... |
| WL 303 | MR | 109 | 106 | 109 |
| WL 306 | R | 112 | 104 | ... |
| 123 | R | 104 | 101 | 111 |
| 131 | R | 107 | 102 | 98 |
| 153 | S | 101 | 105 | 97 |
| 235 | R | 106 | ... | ... |
| 520 | R | 108 | 104 | 96 |
| 525 | R | 106 | 104 | 110 |
| 530 | R | 102 | 102 | 97 |

[a] The check varieties include Vernal, Ranger, Atlantic, Buffalo, Narragansett, Saranac, Dawson, and Kanza. The performance of a variety was tested against one or more of these check varieties appearing in the trials.
[b] S = susceptible.
[c] R = resistant.
[d] MR = moderately resistant.

animals, to reduce late winter heaving damage, to increase drying rate, and perhaps to improve animal acceptance. Mixtures of two or three well-chosen species are usually higher yielding than mixtures of five or six species of which some are often not particularly well suited.

## Pollination of Legume Seeds

Illinois has always been an important producer of legume seeds, particularly red clover. In both acreage and seed produced, Illinois leads the nation. Yet per-acre yields are generally low, in part because of inadequate pollination by bees. Only during the second bloom do honey bees visit red clover in high enough numbers to pollinate it while they collect pollen and nectar. In experiments on the Agronomy Farm at Urbana, honey bees collected 54 to 99 percent of their daily pollen intake from red clover between July 12 and August 3.

Bumblebees also pollinate red clover, but they cannot

Table 30. — Red Clover Variety Yields, 1974-75

| Variety | Anthracnose resistance | Tons dry matter per acre | |
|---|---|---|---|
| | | DeKalb | Urbana |
| Arlington | Northern | 3.60 | 3.76 |
| Chesapeake | Southern | 2.89 | 3.44 |
| Dollard | Northern | 3.31 | 2.76 |
| E688 | ........ | 3.34 | 3.60 |
| Kenland | Southern | 2.67 | 3.51 |
| Kenstar | Southern | .... | 3.43 |
| Lakeland | Northern | 3.21 | 3.05 |
| Pennscott | Southern | 2.63 | 2.74 |
| Redland | Southern | 3.38 | 3.34 |
| Truver[a] | Northern | 3.34 | 3.05 |

[a] A mammoth red clover.

Table 31. — Timothy Variety Yields, 1974-75

| Variety | Tons dry matter per acre | | |
|---|---|---|---|
| | DeKalb | Urbana | Brownstown |
| Clair | 3.91 | 3.58 | 3.99 |
| Climax | 3.81 | 3.46 | 4.84 |
| Itasca | 3.39 | 3.65 | ... |
| N7-126 | 3.71 | 3.64 | 4.00 |
| Timfor | 3.64 | 3.79 | 4.40 |
| Toro | 3.74 | 3.69 | ... |
| Verdant | 3.39 | 3.90 | ... |

Table 32. — Smooth Bromegrass Variety Yields, 1974-75

| Variety | Tons dry matter per acre | | |
|---|---|---|---|
| | DeKalb | Urbana | Brownstown |
| Barton | 4.37 | 3.44 | 4.27 |
| Baylor | 3.75 | 3.44 | 3.98 |
| Beacon | 3.72 | 3.62 | 3.58 |
| Blair | 4.13 | 3.55 | 3.58 |
| Lincoln | 3.76 | 3.39 | 3.56 |
| Sac | 3.48 | 3.01 | 3.51 |

Table 33. — Orchardgrass Variety Yields, 1974-75

| Variety | Tons dry matter per acre | | |
|---|---|---|---|
| | DeKalb | Urbana | Brownstown |
| Able | 3.28 | 3.28 | 4.18 |
| Boone | 3.21 | 2.95 | 4.43 |
| Dart | 3.55 | 3.11 | 4.55 |
| Dayton | 3.52 | 2.98 | 3.85 |
| Hallmark | 3.49 | 3.31 | 4.03 |
| Ina | 3.13 | 3.05 | 4.29 |
| Jackson | 3.62 | 3.17 | 4.18 |
| Napier | 3.26 | 3.15 | 4.35 |
| Potomac | 3.31 | 3.29 | 3.71 |

## Table 34. — Other Hay, Pasture, and Silage Crop Varieties

| Crop | Variety | Origin | Use | Relative maturity (days)[a] |
|---|---|---|---|---|
| Ladino clover | Merit | Iowa | Pasture | |
| Birdsfoot trefoil | Empire | New York | Pasture | |
| | Dawn | Missouri | Pasture | |
| | Viking | New York | Hay and pasture | |
| | Leo | Canada | Hay and pasture | |
| Crownvetch | Penngift | Pennsylvania | Erosion and pasture | |
| | Chemung | New York | Erosion and pasture | |
| | Emerald | Iowa | Erosion and pasture | |
| Smooth bromegrass | Achenbach | Kansas | Hay and pasture | |
| | Barton | Land O' Lakes, Inc. | Hay and pasture | |
| | Baylor | Rudy Patrick Co. | Hay and pasture | |
| | Beacon | Land O' Lakes, Inc. | Hay and pasture | |
| | Blair | Rudy Patrick Co. | Hay and pasture | |
| | Fox | Minnesota | Hay and pasture | 0 |
| | Lincoln | Nebraska | Hay and pasture | 0 |
| | Saratoga | New York | Hay and pasture | |
| | Sac | Wisconsin | Hay and pasture | |
| | Southland | Oklahoma | Hay and pasture | |
| Orchardgrass | Able | Farm Forage Research Coop. | Hay and pasture | late |
| | Boone | Kentucky | Hay and pasture | 0 |
| | Brage | Sweden | Hay and pasture | +10 |
| | Danish | Denmark | Hay and pasture | +10 |
| | Dart | Land O' Lakes, Inc. | Hay and pasture | +2 |
| | Dayton | Rudy Patrick Co. | Hay and pasture | +1 |
| | Dolcea | Holland | Hay and pasture | late |
| | Hallmark | Farm Forage Res. Coop. | Hay and pasture | +3 |
| | Ina | Northrup, King & Co. | Hay and pasture | +8 |
| | Jackson | Virginia | Hay and pasture | +7 |
| | Napier | Rudy Patrick Co. | Hay and pasture | +3 |
| | Pennlate | Pennsylvania | Hay and pasture | +11 |
| | Pennmead | Pennsylvania | Hay and pasture | +8 |
| | Plano | Holland | Pasture | early |
| | Potomac | Maryland | Hay and pasture | 0 |
| | Sterling | Iowa | Hay and pasture | +2 |
| | S-37 | Wales | Hay and pasture | +11 |
| | Va-70 | Virginia | Hay and pasture | −1 |
| Tall fescue | Alta | Oregon | Pasture | |
| | Aronde | Holland | | early |
| | Fawn | Oregon | Pasture | |
| | Goar | California | Pasture | |
| | Kenmont | Kentucky | Pasture | |
| | Kenwell | Kentucky | Pasture (more palatable) | |
| | Ky-31 | Kentucky | Pasture | |
| | Pastuca | Holland | | late |
| Timothy | Clair | Kentucky | Hay | 0 |
| | Climax | Indiana | Hay | +15 |
| | Itasca | Minnesota | Hay | 0 |
| | Timfor | Northrup, King & Co. | Hay | 0 |
| | Toro | Rudy Patrick Co. | | |
| | Verdant | Wisconsin | Hay | +20 |

[a] Maturity relative to a popular variety within the species.

## Table 35. — Forage Seed Mixture Recommendations for Rotation and Permanent Pastures, Hay Crops, Hog Pastures, and Horse Pastures

### For Hay Crops

#### Central and Northern Illinois

| *Well-drained soils* | *Pounds per acre* |
|---|---|
| Alfalfa | 12 lb. |
| | |
| Alfalfa | 8 lb. |
| Bromegrass | 6 lb. |
| | |
| Alfalfa | 8 lb. |
| Bromegrass | 4 lb. |
| Timothy | 2 lb. |
| | |
| Alfalfa | 8 lb. |
| Timothy | 4 lb. |

| *Poorly drained soils* | |
|---|---|
| Alsike clover | 5 lb. |
| Timothy | 4 lb. |
| | |
| Reed canarygrass | 8 lb. |
| Alsike clover | 3 lb. |
| | |
| Birdsfoot trefoil | 5 lb. |
| Timothy | 2 lb. |

| *Drouthy soils* | |
|---|---|
| Alfalfa | 8 lb. |
| Bromegrass | 6 lb. |
| | |
| Alfalfa | 8 lb. |
| Tall fescue (south and central Illinois only) | 6 lb. |

#### Southern Illinois

| *Well-drained soils* | *Pounds per acre* |
|---|---|
| Alfalfa | 8 lb. |
| Orchardgrass | 6 lb. |
| | |
| Alfalfa | 8 lb. |
| Tall fescue | 6 lb. |

| *Poorly drained soils* | |
|---|---|
| Reed canarygrass | 8 lb. |
| Alsike clover | 4 lb. |
| | |
| Tall fescue | 6 lb. |
| Alsike clover | 4 lb. |
| | |
| Redtop | 4 lb. |
| Alsike clover | 4 lb. |

| *Drouthy soils* | |
|---|---|
| Alfalfa | 8 lb. |
| Orchardgrass | 4 lb. |
| | |
| Alfalfa | 8 lb. |
| Tall fescue | 6 lb. |
| | |
| Alfalfa | 8 lb. |
| Bromegrass | 6 lb. |

### For Horse Pastures

#### Central and Northern Illinois

| | |
|---|---|
| Alfalfa | 6 lb. |
| Smooth bromegrass | 6 lb. |
| Kentucky bluegrass | 2 lb. |
| | |
| Smooth bromegrass | 6 lb. |
| Kentucky bluegrass | 2 lb. |
| Timothy | 2 lb. |
| Ladino clover | ½ lb. |

#### Central Illinois

| | |
|---|---|
| Alfalfa | 6 lb. |
| Orchardgrass | 3 lb. |
| Kentucky bluegrass | 2 lb. |
| | |
| Orchardgrass | 6 lb. |
| Kentucky bluegrass | 2 lb. |
| Ladino clover | ½ lb. |

#### Southern Illinois

| | |
|---|---|
| Alfalfa | 8 lb. |
| Orchardgrass | 3 lb. |
| Kentucky bluegrass | 5 lb. |
| | |
| Orchardgrass | 6 lb. |
| Kentucky bluegrass | 5 lb. |
| Ladino clover | ½ lb. |

### For Hog Pastures

*(for anywhere in Illinois)*

| | |
|---|---|
| Alfalfa | 6 lb. |
| Ladino | 2 lb. |

### For Rotation and Permanent Pastures

#### Central and Northern Illinois

| *Well-drained soils* | *Pounds per acre* |
|---|---|
| Alfalfa | 6 lb. |
| Bromegrass | 5 lb. |
| Timothy | 2 lb. |
| | |
| Alfalfa | 6 lb. |
| Orchardgrass[a] | 4 lb. |
| | |
| Alfalfa | 6 lb. |
| Orchardgrass[a] | 4 lb. |
| Timothy | 2 lb. |
| | |
| Orchardgrass[a] | 6 lb. |
| Ladino clover | ½ lb. |
| | |
| Red clover | 8 lb. |
| Ladino clover | ½ lb. |
| Orchardgrass[a] | 6 lb. |
| | |
| Red clover | 8 lb. |
| Ladino clover | ½ lb. |
| Tall fescue | 6-8 lb. |
| | |
| Birdsfoot trefoil | 5 lb. |
| Timothy | 2 lb. |
| | |
| Bromegrass | 8 lb. |
| Ladino clover | ½ lb. |
| | |
| Tall fescue | 10 lb. |
| | |
| Orchardgrass[a] | 8 lb. |

| *Poorly drained soils* | |
|---|---|
| Alsike clover | 3 lb. |
| Ladino clover | ¼ lb. |
| Timothy | 4 lb. |
| | |
| Birdsfoot trefoil | 5 lb. |
| Timothy | 2 lb. |
| | |
| Reed canarygrass | 8 lb. |
| Alsike clover | 3 lb. |
| Ladino clover | ¼-½ lb. |
| | |
| Alsike clover | 2 lb. |
| Tall fescue | 8 lb. |
| Ladino clover | ½ lb. |

| *Drouthy soils* | |
|---|---|
| Alfalfa | 6 lb. |
| Bromegrass | 5 lb. |
| | |
| Alfalfa | 6-8 lb. |
| Orchardgrass[a] | 4 lb. |
| | |
| Alfalfa | 6-8 lb. |
| Tall fescue | 6 lb. |
| | |
| Red clover | 8 lb. |
| Ladino clover | ½ lb. |
| Orchardgrass[a] | 6 lb. |
| | |
| Red clover | 8 lb. |
| Ladino clover | ½ lb. |
| Tall fescue | 6-8 lb. |

[a] Central Illinois only.

#### Southern Illinois

| *Well-drained soils* | *Pounds per acre* |
|---|---|
| Alfalfa | 8 lb. |
| Orchardgrass | 4 lb. |
| | |
| Alfalfa | 8 lb. |
| Tall fescue | 6 lb. |
| | |
| Tall fescue | 8 lb. |
| Ladino clover | ½ lb. |
| | |
| Alfalfa | 8 lb. |
| Bromegrass | 6 lb. |
| Timothy | 2 lb. |
| | |
| Orchardgrass | 6 lb. |
| Ladino clover | ½ lb. |
| | |
| Tall fescue | 10 lb. |
| | |
| Orchardgrass | 8 lb. |
| | |
| Red clover | 8 lb. |
| Ladino clover | ½ lb. |
| Orchardgrass | 6 lb. |
| | |
| Red clover | 8 lb. |
| Ladino clover | ½ lb. |
| Tall fescue | 6-8 lb. |

| *Poorly drained soils* | |
|---|---|
| Alsike clover | 2 lb. |
| Tall fescue | 8 lb. |
| Ladino clover | ½ lb. |
| | |
| Reed canarygrass | 8 lb. |
| Alsike clover | 3 lb. |
| Ladino clover | ½ lb. |

| *Drouthy soils* | |
|---|---|
| Alfalfa | 8 lb. |
| Orchardgrass | 4 lb. |
| | |
| Alfalfa | 8 lb. |
| Tall fescue | 6 lb. |
| | |
| Red clover | 8 lb. |
| Ladino clover | ½ lb. |
| Orchardgrass | 6 lb. |
| | |
| Red clover | 8 lb. |
| Ladino clover | ½ lb. |
| Tall fescue | 6-8 lb. |

be relied on because they are not always present and their numbers are unpredictable. Even the presence of honey bees in the vicinity of red clover fields can no longer be assured, because hive numbers in Illinois are now estimated at only 49,000 compared with about 76,000 hives in 1970, and 140,000 in 1958.

If you produce red clover seed, do so on the second crop and use at least two colonies of honey bees per acre within or beside the field. On large fields place them in two or more groups. Do not rely on bees present in the neighborhood, because pollination and seed set decreases rapidly as distance between the hives and the crop becomes greater than 800 feet. Bring a sufficient number of hives to the field as soon as it comes into bloom. When all factors for seed production are favorable, proper pollination of red clover by honey bees has the potential of doubling or tripling seed yields.

White and yellow sweetclovers are highly attractive to bees and other insects. However, probably because of the large number of blossoms, their seed yields increase when colonies of honey bees are placed nearby. Yields up to 1,400 pounds per acre have been produced in the Midwest by using six colonies of bees per acre. One or two hives per acre will provide reasonably good pollination.

Crownvetch does not attract bees and requires special techniques to produce a commercial crop of seed. Best yields have been obtained by bringing strong, new hives of bees to the fields every 8 to 10 days. In place of such special provisions, one or more hives of honey bees per acre of crownvetch are of value.

The effects of insect pollination on annual lespedeza, such as Korean, have not been investigated. However, the perennial lespedezas require insect pollination to produce a crop of seed, and honey bees can be used.

Many legumes grown in Illinois for pasture or for purposes other than seed production are visited by honey bees and other bee pollinators. Alfalfa and birdsfoot trefoil, as well as alsike, white, and Ladino clovers all provide some pollen and nectar and, in turn, are pollinated to varying degrees.

Soybeans are visited by honey bees, especially in late July and early August at Urbana. The beans were a major source of honey in the state in 1974. In tests at Urbana, honey bee visits to Clark soybeans did not increase seed yield over that of plants caged to exclude bees. Other studies showed, however, that honey bees can cross-pollinate some soybean varieties. Yields of Corsoy were increased 14 percent and Hark varieties 16 percent by honey bee visits in recent experiments in Wisconsin. Honey bees had no effect on yields of Chippewa 64 in the same study. It seems likely that other varieties also are benefited by visits of honey bees to their blossoms.

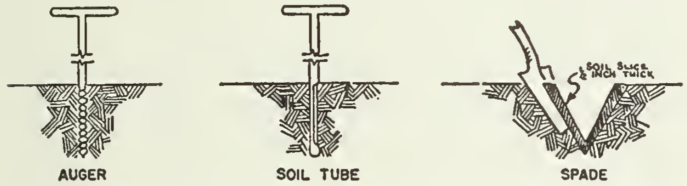
## SOIL TESTING AND FERTILITY

### Soil Testing

Soil testing is the most important single guide to the profitable application of fertilizer and lime. When soil test results are combined with information about the nutrients that are available to the various crops from the soil profile the farmer has a reliable basis for planning his fertility program on each field.

Traditionally, soil testing has been used to decide how much lime and fertilizer to apply. Today, with increased emphasis on the environment, soil tests are also a logical tool to determine areas where adequate or excessive fertilization has taken place. It is just as important to determine where fertilizers should not be used.

**How to sample.** A soil tube is the best implement to use for taking soil samples, but a shovel or auger can also be used (Fig. 3). One composite sample from every 3 to 4 acres is suggested. Five soil cores taken with a tube will give a satisfactory composite sample of approximately 1 to 2 cups in size. You may follow a regular pattern as indicated in Figure 4.




**How to take soil samples with an auger, soil tube, and spade. (Fig. 3)**

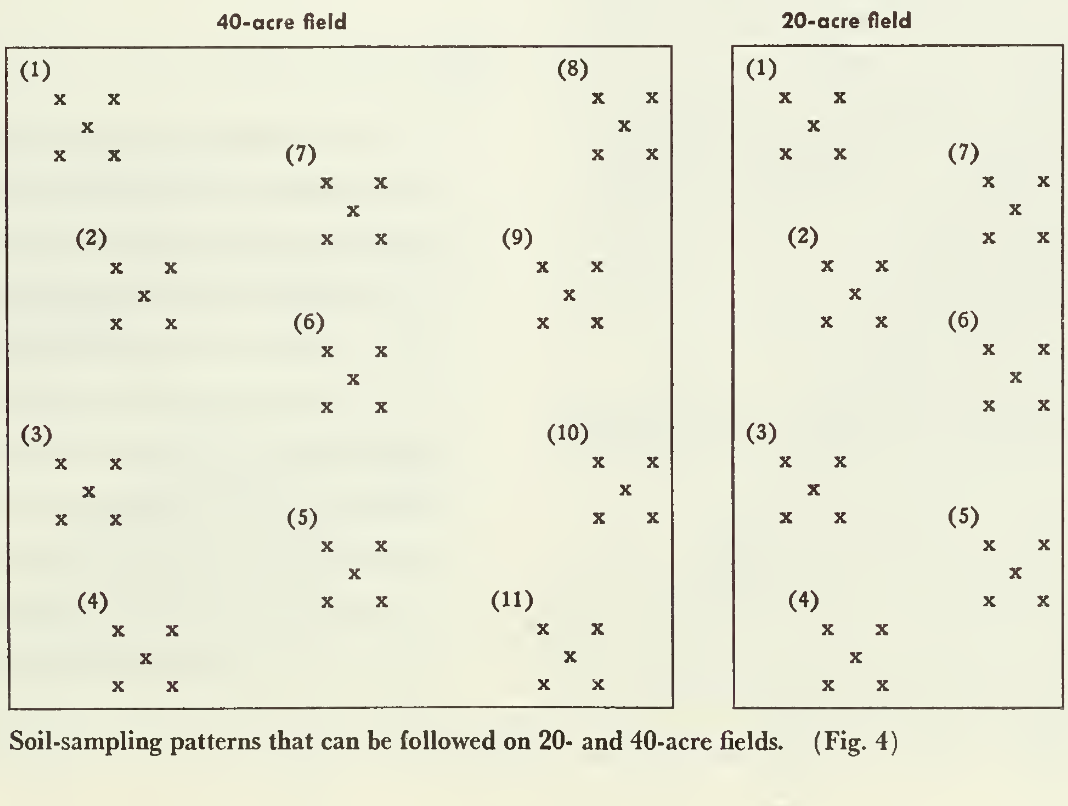
The most common mistake is to take too few samples to represent the fields adequately. Following shortcuts in sampling may produce unreliable results and lead to higher fertilizer costs or lower returns or both.

**When to sample.** Sampling every four years is strongly suggested. Late summer and fall are the best seasons to collect soil samples from the field. Potassium test results are most reliable during these times. Sampling frozen soil or within a two-week period after being frozen should be avoided.

**Where to have soil tested.** Illinois has about 65 commercial soil testing services. If you do not know of any, your county extension adviser or fertilizer dealer can advise you of availability of soil testing in your area.

**Information to accompany soil samples.** The best fertilizer recommendations made are those which are based both on the soil test results and a knowledge of the conditions in the field which will affect nutrient availability. Since the person making the recommendation does not know the conditions of each field it is important that you provide adequate information with each sample.

This necessary information includes: cropping intention for the next four years; what is the nature of the soil (clay, silty, or sandy; light or dark colored; level or hilly; erodes; well drained or wet; tiled or not; deep or shallow soil); what fertilizer you have been using (amount and grade); was the field limed in the past two years; yield goals for all proposed crops.




**Soil-sampling patterns that can be followed on 20- and 40-acre fields. (Fig. 4)**

**What tests to have made.** Illinois soil-testing laboratories are equipped to test soils for pH (soil acidity), $P_1$ (available phosphorus), and K (potassium). No test for nitrogen has proven successful enough to justify a recommendation by University of Illinois agronomists. The reserve phosphorus soil test ($P_2$) has been discontinued in most laboratories. Rock phosphate usage has decreased, so the need for the test has diminished.

Soil tests for certain secondary and micronutrients may warrant consideration under particular circumstances. These tests may be useful for:

1. *Trouble shooting.* Diagnosing symptoms of abnormal growth. Paired samples representing areas of good and poor growth are needed for analyses.

2. *"Hidden-hunger checkup."* Identifying deficiencies before symptoms appear. Soil tests have little value in indicating marginal levels of secondary and micronutrients when crop growth is apparently normal. For this purpose, plant analysis may yield more useful information.

Tests may be made for most of the secondary and micronutrients, but the interpretation is less reliable than the tests for lime, phosphorus, or potassium. Complete field history and soil information are especially important in interpreting the results of these tests.

## Lime

The liming program is being short-changed on a growing number of Illinois farms. One of the most serious limitations in crop production is soil acidity. The use of nitrogen fertilizer has rapidly increased, but the tonnage of limestone has not kept pace. In Illinois, limestone usage ranged from 4.7 to 4.9 million tons from 1963 to 1966, but declined to 3.7 to 4.1 million tons in 1971 and 1972, while the use of nitrogen fertilizer increased from 175,000 tons in 1963 to 596,000 tons in 1972. It requires about four pounds of lime to neutralize the acidity resulting from one pound of nitrogen applied as ammonia or urea and as much as nine pounds of lime to neutralize the acidity resulting from one pound of nitrogen as ammonium sulfate. A soil test every four years is the best way to keep check on soil acidity levels.

**The effect of soil acidity on plant growth.** There are several ways soil acidity affects plant growth. Whenever soil pH is low (i.e., acidity is high) several situations may exist.

1. The concentration of soluble metals may be toxic. Excess solubility of aluminum and manganese has been established experimentally.

2. Populations and activities of the organisms responsible for transformations involving nitrogen, sulfur, and phosphorus may be altered.

3. Calcium may be deficient under certain situations. This usually occurs when the cation exchange capacity of the soil is extremely low.

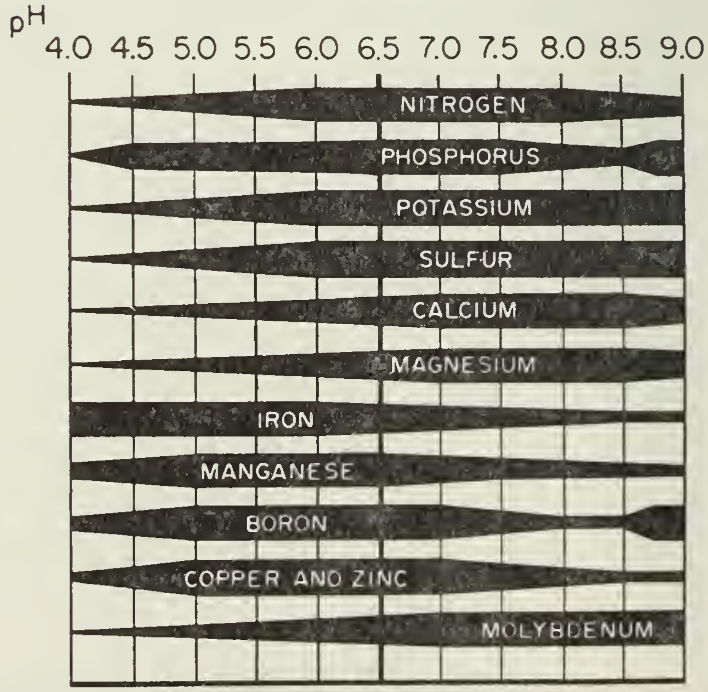
4. Symbiotic nitrogen fixation is greatly impaired on acid soils. The symbiotic relationship requires a narrower range of soil reaction than is necessary for growth of plants not relying on N fixation.

5. Acidic soils are poorly aggregated and have poor tilth. This is particularly true for soils low in organic matter.

6. Availability of mineral elements to plants may be improved (Fig. 5). For example, phosphorus availability is greatest in the pH range between 6.5 and 7.5, dropping off rapidly below 6.0. Molybdenum availability is greatly increased as soil acidity is decreased. Molybdenum deficiencies can usually be corrected by liming. Figure 3 shows the nutrient availability as influenced by soil pH. The wider the shaded bar, the greater the nutrient availability.

**Suggested pH goals.** For cropping systems with alfalfa and clover, aim for a pH of 6.5 or above unless the soils are pH 6.2 or above without ever having been limed. In those soils, neutral soil is just below plow depth and it will probably not be necessary to apply limestone.

For cash-grain systems (no alfalfa or clover), maintaining a pH of at least 6.0 is a realistic goal. If the soil test shows that the pH is 6.0, apply limestone to prevent a drop in pH below 6.0. Farmers may choose to raise the pH to still higher levels. After the initial investment, it costs little more to maintain a pH of 6.5 than 6.0. The profit over a 10-year period will be affected very little, since the increased yield will about offset the original




**Available nutrients in relation to pH. (Fig. 5)**

cost of the extra limestone (2 or 3 tons per acre) plus interest.

Research indicates that a profitable yield response from raising the pH above 6.5 in cash-grain systems is unlikely.

**Liming treatments based on soil tests.** The limestone requirements in Figure 6 are based on these assumptions.

1. A nine-inch plowing depth. If plowing is less than nine inches deep, reduce the amount of limestone; if more than nine inches, increase the lime rate proportionately.

2. Typical fineness of limestone: 90 percent through 8-mesh; 60 percent through 30-mesh; 30 percent through 60-mesh. If the limestone is not as fine as indicated above and if a quick effect is desired, apply more limestone than indicated in the charts.

3. A calcium carbonate equivalent (total neutralizing power) of 90 percent. The rate of application may be adjusted according to the deviation from 90.

Instructions for using Figure 6 are as follows:

1. Use Chart I for grain systems and Chart II for alfalfa, clover, or lespedeza.

2. Decide which soil class fits your soil:

A. Dark-colored silty clays and silty clay loams.

B. Light- and medium-colored silty clays and silty clay loams; dark-colored silt and clay loams.

C. Light- and medium-colored silt and clay loams; dark- and medium-colored loams; dark-colored sandy loams.

D. Light-colored loams; light- and medium-colored sandy loams; sands.

E. Muck and peat.

**Table 36. — Comparative Value of Limestone Particle Sizes**

| Size fraction | Efficiency factor |
|---|---|
| Through 60 mesh | 100 |
| 30 to 60 mesh | 50 |
| 8 to 30 mesh | 20 |
| Over 8 mesh | 5 |

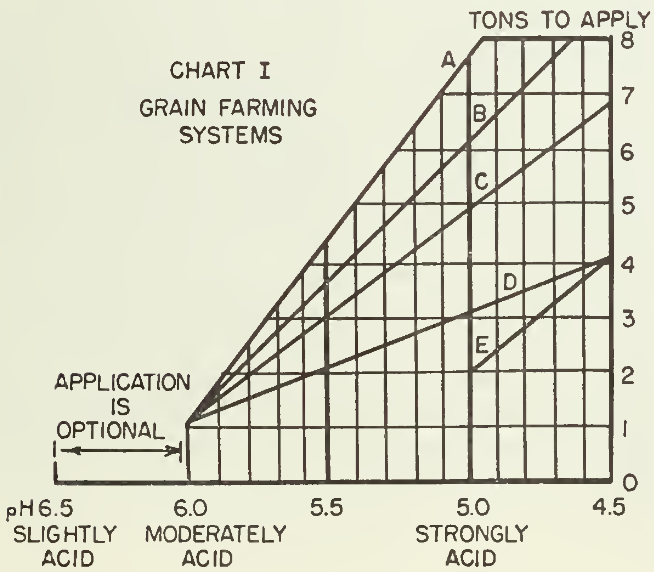
Color is related to organic matter. Light-colored soils usually have less than 2.5 percent organic matter; medium-colored soils have 2.5 to 4.5 percent organic matter; dark-colored soils have above 4.5 percent organic matter; sands are excluded.

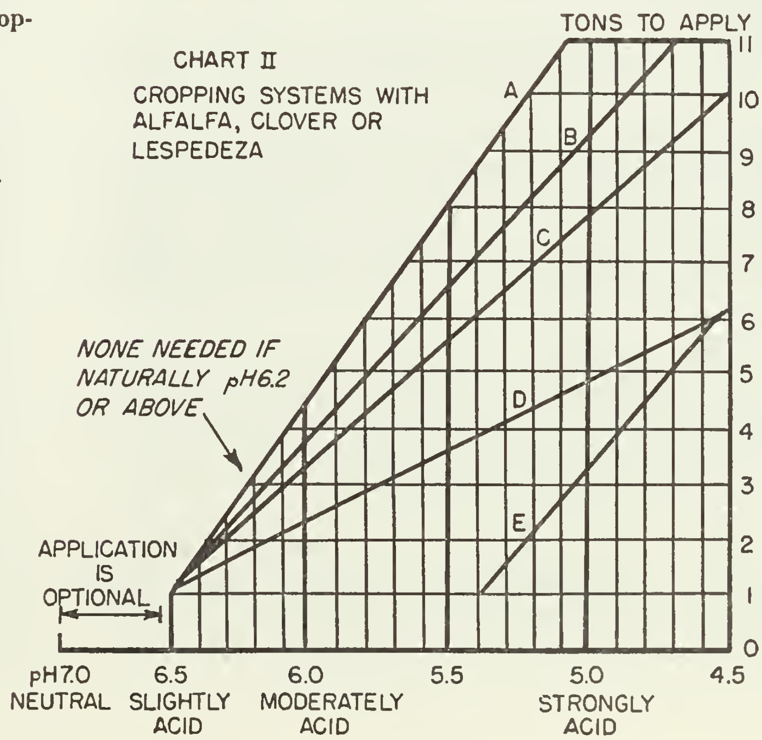
The "typical" limestone on which Charts I and II are based has an effective neutralizing value (ENV) of 46.35. Here are the steps to follow (using the fineness and neutralizing power values) to calculate the ENV of your limestone.

First, determine what percentages of the limestone particles fall into four size groups. Then, multiply these four percentages by the efficiency factors (E.F.) listed in Table 36 to obtain the size fraction efficiency. Total the size fraction efficiencies to obtain the fineness efficiency as illustrated below.

| | *% × E.F. = Size fraction efficiency* |
|---|---|
| 10% of lime particles do not pass 8 mesh | 0.10 × 5 = 0.5 |
| 30% of particles pass 8 mesh, but do not pass 30 mesh | 0.30 × 20 = 6.0 |
| 30% of particles pass 30 mesh, but do not pass 60 mesh | 0.30 × 50 = 15.0 |
| 30% of particles pass 60 mesh | 0.30 × 100 = 30.0 |
| Fineness efficiency | 51.5 |

**Suggested limestone rates based on soil type, pH, and cropping system. (Fig. 6)**



Then, the effective neutralizing value will equal the fineness efficiency multiplied by the calcium carbonate equivalent ($46.35 = 51.5 \times 90$ percent). Your limestone dealer can tell you what the calcium carbonate equivalent of your limestone is.

**Limestone quality.** You should buy limestone on the basis of quality as you would seed or a tractor or any other item. Premium limestone should sell for a premium price.

Limestone quality is measured by its fineness and neutralizing power. The value of lime in correcting soil acidity problems can be easily calculated using the efficiency factors in Table 36.

To compare different limestones to the typical limestone on which Charts I and II are based, follow this procedure:

1. Calculate the ENV for your limestone as explained above.

2. Divide 46.35 (the ENV for typical limestone) by the calculated ENV value for your limestone.

**ENV greater than typical limestone.** If the fineness efficiency value of your limestone is 49.5 to 53.5, you may reduce the amount of lime to use by 1 percent for each 1 percent of calcium carbonate equivalent above 90 percent.

If the ENV of your limestone is greater than 46.35, and the calcium carbonate equivalent is 88 to 92 percent, then the increase in ENV is due to the fineness of the grind, and no adjustment in the amount of lime used per acre is justified. However, the finer grind materials will react more rapidly to neutralize acid soils than the typical limestone, and this may be of benefit in some situations.

**ENV less than typical limestone.** If your limestone has an ENV less than 46.35, then you should increase the amount to apply per acre. Divide the amount of limestone needed per acre on your land by the fineness efficiency value you calculated in step 2 above (for instance, two tons per acre divided by a fineness efficiency value of 0.9 would equal about 2.22 tons to apply per acre).

If high initial cost is not a deterrent, you may apply the entire amount at one time. If cost is a factor and the amount of limestone needed is six tons or more per acre, apply it in split applications of about two-thirds the first time and the remainder three or four years later.

**Lime incorporation.** Lime does not react with acid soil very far from the particle. However, special tillage operations to mix lime with soil are usually not necessary; this has been true with so-called conventional tillage which included the mold board plow. Non-moldboard plow systems of tillage (i.e., chisel plow and field cultivator) may necessitate a reexamination of soil acidity patterns within the root zone.

## Calcium-Magnesium Balance in Illinois Soils

Soils in northern Illinois usually contain more magnesium than those in central and southern sections because of the high magnesium content in the rock from which the soils developed and because northern soils are geographically younger. This has caused some to wonder whether the magnesium was too high. There have been reports of suggestions that either gypsum or low-magnesium limestone from southern Illinois quarries should be applied. No one operating a soil-testing laboratory or selling fertilizer in Illinois has put forth research to justify concern over too narrow a calcium:magnesium ratio.

On the other end, there is justifiable concern over a soil magnesium level that is low, because of its implication with hypomagnesia (grass tetany in dairy cattle) in livestock. This is more relevant to forage production than to grain production. "Quality" of forage production seems to be at issue rather than total yield. Very high potassium levels (500+) combined with low soil magnesium levels contribute to low magnesium forages. Research data to recommend specific magnesium levels is not available. However, levels of Mg below 40 pounds per acre on sands and 150 pounds per acre on silt loam are regarded as low.

Calcium and magnesium levels of agricultural limestone varies from different quarries in the state. Dolomite limestone (material with an appreciable magnesium content as high as 21.7 percent MgO or 46.5 percent $MgCO_3$) predominantly occurs in the northern three tiers of Illinois counties, including Kankakee County on the east and an additional area in Calhoun County. Limestone in the remainder of the state is dominantly calcitic (high calcium although it is not uncommon to have 1 to 3 percent $MgCO_3$).

For farmers following a grain system of farming there are no agronomic reasons to recommend either that farmers in northern Illinois bypass local sources, which are medium to high in magnesium, and pay a premium for low-magnesium limestone from southern Illinois. Nor should farmers in southern Illinois order limestone from northern Illinois quarries because of magnesium content.

For farmers with a livestock program or who produce forages in the claypan and fragipan regions of the south where soil magnesium levels may be marginal, it is appropriate to use a soil test to verify the conditions and to use dolomite limestone or supplemental magnesium fertilization.

**Table 37. — Economic Optima Nitrogen Rates Experimentally Determined for Eight Locations as Affected by Corn-Nitrogen Price Ratios**

| Location and rotation | Corn-nitrogen price ratio 10:1 | | 20:1 | |
|---|---|---|---|---|
| | Optimum yield (bu./acre) | Optimum N rate (lb./bu.) | Optimum yield (bu./acre) | Optimum N rate (lb./bu.) |
| Brownstown (continuous corn) | 83 | 1.30 | 86 | 1.47 |
| Carthage (continuous corn) | 144 | 1.22 | 147 | 1.29 |
| DeKalb (continuous corn) | 141 | 1.28 | 143 | 1.31 |
| Urbana (continuous corn) | 171 | 1.17 | 173 | 1.24 |
| Average of continuous corn | | 1.24 | | 1.33 |
| Dixon (corn-soybeans) | 131 | 1.37 | 134 | 1.58 |
| Hartsburg (corn-soybeans) | 156 | 1.19 | 157 | 1.27 |
| Oblong (corn-soybeans) | 123 | 1.11 | 126 | 1.23 |
| Toledo (corn-soybeans) | 123 | 1.12 | 124 | 1.20 |
| Average of corn-soybeans | | 1.20 | | 1.32 |
| Average of all locations | | 1.22 | | 1.32 |

## Nitrogen

Harvested crops remove more nitrogen than any other nutrient from Illinois soils. Erosion reduces the nitrogen content of soils because the surface soil is richest in nitrogen and erodes first. Further nitrogen losses occur as a result of denitrification and leaching. About 40 percent of the original nitrogen and organic matter content have been lost from typical Illinois soils since farming began.

The use of nitrogen fertilizer is necessary if Illinois agriculture is to continue to provide adequate crop production to aid in meeting the ever-increasing world demand for food. With the world shortage of nitrogen fertilizer and energy, all nitrogen fertilizers should be used in the most efficient manner possible. Factors which influence fertilizer use efficiency are discussed in the following sections.

### Rate of Application

**Corn.** Yield goal is one of the major considerations to use in determining the optimum rate of nitrogen application for corn. These goals should be established for each field, taking into account the soil type and management level under which the crop will grow.

For Illinois soils, suggested productivity index values are given in Illinois Extension Circular 1016, "Productivity of Illinois Soils." Yield goals are presented for both basic and high levels of management. For fields that will be under exceptionally high management, an increase of the values given for high levels of management by 15 to 20 percent would be reasonable. Annual variations in yield of 20 percent above or below the productivity index values are common due to variations in weather conditions. However, applying nitrogen fertilizer for yields possible in the most favorable year will not result in maximum net return when averaged over all years.

The University of Illinois Department of Agronomy has conducted research trials designed to determine the optimum nitrogen rate for corn under varying soil and climatic conditions.

These experimental results indicate that the *economic optima nitrogen rates* varied from 1.22 to 1.32 pounds of nitrogen per bushel of corn produced when nitrogen was spring applied (Table 37). The lower rate of application (1.22 pounds) would be recommended at a corn-nitrogen price ratio (corn price per bushel to nitrogen price per pound) of 10:1 and the higher rate (1.32 pounds) at a price ratio of 20:1.

As would be expected, the nitrogen requirement was lower at those sites having a corn-soybean rotation, as compared with continuous corn due to the nitrogen contribution from soybeans (see nitrogen rate adjustment section).

With the exception of Dixon, which was based on only two years of data, Brownstown and DeKalb had the highest nitrogen requirement per bushel of corn produced. This higher requirement, as compared with Carthage and Urbana, may be due in part to higher denitrification losses which have frequently been observed at Brownstown and DeKalb.

Based on these results, examples of the recommended rate of nitrogen application for selected Illinois soils under a high level of management are indicated in Table 38.

**Soybeans.** Based on average Illinois corn and soybean yields from 1971-73 and average nitrogen content of the grain for these two crops, the total nitrogen removed per acre by soybeans was greater than that removed by

**Table 38. — Nitrogen Recommendations for Selected Illinois Soils Under High Level of Management**

| Soil type | Corn-nitrogen price ratio | |
|---|---|---|
| | 10:1 | 20:1 |
| | *Nitrogen recommendation (lb./acre)* | |
| Muscatine silt loam | 177 | 191 |
| Ipava silt loam | 173 | 187 |
| Sable silty clay loam | 166 | 180 |
| Drummer silty clay loam | 163 | 177 |
| Hartsburg silty clay loam | 160 | 173 |
| Plano silt loam | 160 | 173 |
| Cowden silt loam | 133 | 144 |
| Fayette silt loam | 129 | 140 |
| Clinton silt loam | 127 | 137 |
| Cisne silt loam | 122 | 132 |
| Bluford silt loam | 110 | 118 |
| Grantsburg silt loam | 85 | 92 |
| Huey silt loam | 68 | 74 |

**Table 39. — Soybean Yields at Four Locations as Affected by N Applied to Corn the Preceding Year (Four-Year Average)**

| N applied to corn (lb./acre) | Soybean yield (bu./acres) | | | | |
|---|---|---|---|---|---|
| | Aledo | Dixon | Elwood | Kewanee | Average |
| 0 | 48 | 40 | 37 | 40 | 41 |
| 80 | 49 | 40 | 36 | 38 | 41 |
| 160 | 48 | 39 | 36 | 40 | 41 |
| 240 | 48 | 42 | 36 | 40 | 41 |
| 320 | 48 | 42 | 36 | 37 | 41 |

**Table 40. — Yield of Continuous Soybeans With Rates of Added N at Hartsburg**

| N (lb./acre/year) | Soybean yield (bu./acre) | |
|---|---|---|
| | 1968-71 | 1954-71 |
| 0 | 43 | 37 |
| 40 | 42 | 36 |
| 120 | 43 | 37 |

corn (soybeans, 132 pounds of nitrogen per acre; corn, 82 pounds of nitrogen per acre). However, recent research results from the University of Illinois indicate that when properly nodulated soybeans were grown at the proper soil pH, symbiotic fixation was equivalent to 63 percent of the nitrogen removed in harvested grain. Thus, net nitrogen removal by soybeans is less than that of corn (corn, 82; soybeans, 49).

This net removal of nitrogen by soybeans in 1973 was equivalent to 39 percent of the amount of fertilizer nitrogen used in Illinois. On the other hand symbiotic fixation of nitrogen by soybeans in Illinois (367,000 tons of N) was equivalent to 67 percent of the fertilizer nitrogen used in Illinois.

Even though there is a rather large net nitrogen removal from soil by soybeans (49 pounds of nitrogen per acre), research at the University of Illinois has not generally indicated soybean yield increase due to either residual nitrogen remaining in the soil or nitrogen applied for the soybean crop.

**Table 41. — Soybean Yields as Affected by High Rates of Nitrogen**

| Nitrogen (lb./acre) | | | Soybean yield (bu./acre) | | |
|---|---|---|---|---|---|
| 1968 | 1969 | 1970 | 1968 | 1969 | 1970 |
| 0 | 0 | 0 | 54 | 53 | 40 |
| 40 | 200 | 200 | 54 | 57 | 41 |
| 80 | 400 | 400 | 56 | 57 | 45 |
| 120 | 800 | 800 | 53 | 55 | 42 |
| 160 | 1,600 | 1,600 | 55 | 34 | 36 |

Here are some typical results:

*A. Residual from nitrogen applied to corn (Table 39).* Soybean yields at four locations were not increased by residual nitrogen remaining in the soil even when nitrogen rates as high as 320 pounds per acre had been applied to corn the previous year.

*B. Nitrogen on continuous soybeans (Table 40).* After 18 years of continuous soybeans at Hartsburg, yields were unaffected by nitrogen rates.

*C. High rates of added nitrogen (Table 41).* In 1968 a study was started at Urbana using moderate rates of nitrogen. Rates were increased in 1969 so that the high rates could furnish more than the total nitrogen needs of soybeans. Yields were not affected by nitrogen in 1968, but a tendency toward a yield increase occurred in 1969 and 1970 with 400 pounds per acre of nitrogen. However, this rate of nitrogen would not be economical at present prices.

**Wheat, oats, and barley.** The rate of nitrogen application to be used on wheat, oats, and barley is dependent on soil type, variety to be grown, and future cropping intentions (Table 42). Light-colored (low organic matter) soils require the highest rate of nitrogen application as they have a low capacity to supply nitrogen. Deep, dark-colored soils require relatively low rates of nitrogen application for maximum yields. Estimates of organic matter content for soils of Illinois can be obtained from Agronomy Fact Sheet SP-36, "Average Organic Matter Content in Illinois Soil Types," or by using University of Illinois publication AG-1941, "Color Chart for Estimating Organic Matter in Mineral Soils."

Higher rates of application can be used on the stiff-strawed varieties such as Abe, Arthur, Arthur 71, Blueboy, Blueboy II, and Oasis than on the other varieties which are more susceptible to lodging. Nearly all recommended oat varieties grown in Illinois have good straw strength, thus higher nitrogen rates are recommended. Most varieties of barley grown in Illinois are weak strawed and, thus, susceptible to lodging.

Table 42. — Recommended Nitrogen Application Rates for Wheat, Oats, and Barley

| Soil situation | Organic matter content | Fields with alfalfa or clover seeding | | Fields with no alfalfa or clover seeding | |
|---|---|---|---|---|---|
| | | Stiff-strawed varieties | Other adapted wheat and oat varieties and all varieties of barley | Stiff-strawed varieties | Other adapted wheat and oat varieties and all varieties of barley |
| | | *Nitrogen (lb./acre)* | | | |
| Soils low in capacity to supply nitrogen: inherently low in organic matter (forested soils) | <2% | 50–70 | 40–60 | 70–90 | 50–70 |
| Soils medium in capacity to supply nitrogen: moderately dark-colored soils | 2–3% | 30–50 | 20–40 | 50–70 | 30–50 |
| Soils high in capacity to supply nitrogen: all deep, dark-colored soils | >3% | 20–30 | 0 | 40–50 | 20–30 |

Some wheat in Illinois serves as a companion crop for legume or legume grass seedings. On those fields, it is best to apply nitrogen fertilizer slightly below the optimum rate, as unusually heavy vegetative growth of wheat competes unfavorably with the young forage seedlings (Table 42).

Nitrogen fertilizer efficiency will normally be at a maximum if no nitrogen is fall applied to the dark-colored soils and only a small amount (15 to 20 pounds per acre) is drill applied at planting time on the light colored soils. The remainder of the nitrogen should be topdressed early in the spring of the year.

The amount of nitrogen needed for good fall growth is not large because the total uptake in roots and tops prior to cold weather is not likely to exceed 30 to 40 pounds per acre. If all of the recommended nitrogen were fall applied, excessive vegetative growth could occur in the fall and increase the probability for disease occurrence.

**Hay and pasture grasses.** The species grown, period of use, and yield goal determine optimum nitrogen fertilization (Table 43). The lower rate of application is recommended on those fields where an inadequate stand or moisture limits production.

Kentucky bluegrass is shallow rooted and susceptible to drouth. Consequently, the most efficient use of nitrogen by bluegrass is from an early spring application. September applications are second choice. September fertilization stimulates both fall and early spring growth.

Table 43. — Nitrogen Fertilization of Hay and Pasture Grasses

| Species | Time of application | | | |
|---|---|---|---|---|
| | Early spring | After first harvest | After second harvest | Early September |
| | *Nitrogen (lb./acre)* | | | |
| Kentucky bluegrass | 60–80 | | | (see text) |
| Orchardgrass | 75–125 | 75–125 | | |
| Smooth bromegrass | 75–125 | 75–125 | | 50[a] |
| Reed canarygrass | 75–125 | 75–125 | | 50[a] |
| Tall fescue for winter use | | 100–125 | 100–125 | 50[a] |

[a] Optional if extra fall growth is needed.

Orchardgrass, smooth bromegrass, tall fescue, and reed canarygrass are more drouth tolerant than bluegrass and can effectively use higher rates of nitrogen than bluegrass. Because more uniform pasture production is obtained by splitting high rates of nitrogen, two or more applications are suggested.

Make the first nitrogen application in March in southern Illinois, early April in central Illinois, and mid-April in northern Illinois if extra spring growth can be utilized. If spring growth is adequate without extra nitrogen, the first application may be delayed until after the first harvest or grazing cycle to distribute production more uniformly throughout the summer. However, total production will likely be less if nitrogen is applied after first harvest rather than in early spring. The second application of nitrogen is usually made after the first harvest or first grazing cycle. However, this application may be deferred until August or early September to stimulate fall growth.

Legume-grass mixtures should not receive nitrogen if legumes make up 30 percent or more of the mixture. The main objective is to maintain the legume, so emphasis should be on phosphorus and potassium rather than nitrogen.

After the legume has declined to less than 30 percent of the mixture, the objective in fertilizing is to increase the yield of grass. The suggested rate of nitrogen is about 50 pounds per acre when legumes make up 20 to 30 percent of the mixture, and 100 pounds or more when legumes are less than 20 percent of the mixture.

## Rate Adjustments

In addition to determining nitrogen rates, consideration should be given to other agronomic factors which influence available nitrogen. These adjustments include

Table 44. — Adjustments in Nitrogen Recommendations

| Crop to be grown | Soybeans | 1st year after alfalfa or clover: 5 plants/sq. ft. | 1st year: 2-4 plants/sq. ft. | 1st year: <2 plants/sq. ft. | 2nd year after alfalfa or clover: 5 plants/sq. ft. | 2nd year: <5 plants/sq. ft. | Manure[a] |
|---|---|---|---|---|---|---|---|
| | *Nitrogen reduction (lb./acre)* | | | | | | |
| Corn | 40 | 100 | 50 | 0 | 30 | 0 | 5 |
| Wheat | 10 | 30 | 10 | 0 | 0 | 0 | 5 |

(Factors resulting in reduced nitrogen requirement — Previous Crop)

[a] Nitrogen contribution in pounds per ton.

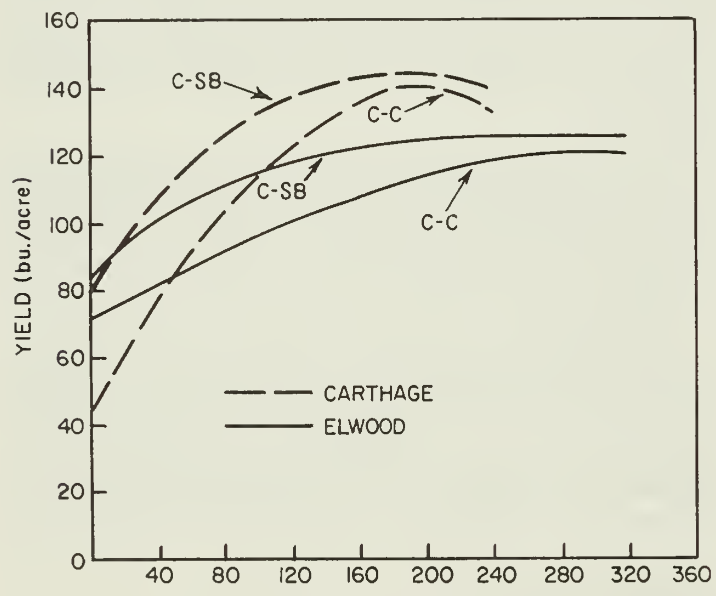
Table 45. — Average Composition of Manure

| Kind of animal | Nitrogen ($N$) (lb./ton) | Phosphorus ($P_2O_5$) (lb./ton) | Potash ($K_2O$) (lb./ton) |
|---|---|---|---|
| Dairy cattle | 11 | 5 | 11 |
| Beef cattle | 14 | 9 | 11 |
| Hogs | 10 | 7 | 8 |
| Chicken | 20 | 16 | 8 |
| Dairy cattle (liquid) | 5(26)[a] | 2(11) | 4(23) |
| Beef cattle (liquid) | 4(21) | 1( 7) | 3(18) |
| Hogs (liquid) | 10(56) | 5(30) | 4(22) |
| Chicken (liquid) | 13(74) | 12(68) | 5(27) |

[a] Parenthetical numbers are pounds of nutrients per 1,000 gallons.

past cropping history and the use of manure (Table 44), as well as date of planting.

Experiments conducted at the Carthage and Elwood experimental fields comparing nitrogen requirements of continuous corn and corn following soybeans indicate a soil nitrogen contribution of 30 to 40 pounds per acre at the lower rates of applied nitrogen and 20 to 30 pounds per acre at the higher rates of nitrogen application at Carthage (Fig. 7). At Elwood the yield differential between continuous corn and corn-soybeans continues to widen at higher rates of nitrogen application. It is doubtful that this yield differential is due entirely to the nitrogen contributions from the soybeans. The contribution of legumes, either soybeans or alfalfa, to wheat will be less than the contribution to corn because the oxidation of the organic nitrogen from these legumes will not be as rapid in early spring, when the nitrogen needs of small grain are greatest, as it is in the summer when nitrogen needed by corn is greatest.




**Effect of crop rotation and applied nitrogen on corn yield. (Fig. 7)**

Manure is generally considered to contain 10 pounds of nitrogen, 5 pounds of phosphate ($P_2O_5$), and 10 pounds of potassium ($K_2O$) per ton. However, there is some variation in content dependent on source and method of handling (Table 45). Irrespective of source, only 50 percent of the total nitrogen will be available to the crop during the first year after application.

Research at the Northern Illinois Research Center for several years showed that as planting was delayed, less nitrogen fertilizer was required for most profitable yield. Based upon that research, Illinois agronomists suggest that for each week of delay in planting after the optimum date for the area, the nitrogen rate may be reduced 20 pounds per acre down to 80 to 90 pounds per acre as the minimum for a corn-soybean cropping system for very late planting. Suggested reference dates are April 10 to 15 in southern Illinois, April 20 to May 1 in central Illinois, and May 1 to 10 in northern Illinois. This adjustment is, of course, possible only if the nitrogen is sidedressed.

Because of the importance of planting date, farmers are encouraged not to delay planting in order to apply nitrogen fertilizer: plant, then sidedress.

## Reactions in the Soil

Application of nitrogen fertilizer to optimize efficiency of usage requires an understanding of how nitrogen behaves in the soil. Key points to consider are the change from ammonium ($NH_4^+$) to nitrate ($NO_3^-$) and movements and transformations of nitrate.

A high percentage of the nitrogen applied in Illinois is in the ammonium form or converts to ammonium (anhydrous ammonia and urea, for example) soon after application. Ammonium nitrogen is held by the soil clay and organic matter and cannot move very far until it nitrifies (changes from ammonium to nitrate). In the nitrate form, nitrogen can be lost by either denitrification or leaching.

**Denitrification.** Denitrification is believed to be the main pathway of nitrate and nitrite nitrogen loss, except on sandy soils where leaching is more important. Denitrification involves only nitrogen in the form of either nitrate ($NO_3^-$) or nitrite ($NO_2^-$).

The amount of denitrification depends mainly on: (1) how long water stands on the soil surface or how long the surface is saturated; (2) the temperature of the soil and water; (3) the pH of the soil, and (4) amount of energy material available to denitrifying organisms.

When water stands on the soil or when the surface is completely saturated in fall or early spring, nitrogen loss in likely to be small because (a) much nitrogen is still in the ammonium rather than nitrate form, and (b) the soil is cool and denitrifying organisms are not very active.

Many fields in east central Illinois and to a lesser extent in other areas have low spots where surface water collects at some time during the spring or summer. The flat clay-pan soils also are likely to be saturated, though not flooded. Sidedressing would avoid the risk of spring loss on these soils, but would not affect midseason loss. Unfortunately, these are the soils on which sidedressing is difficult in wet years.

Denitrification is difficult to measure in the field, but several laboratory studies show that it can happen very fast. At temperatures that are common in midsummer, most nitrate nitrogen can be denitrified within three to five days at pH 6.0 or above.

**Leaching.** In silt loams and clay loams, one inch of rainfall moves down about five to six inches, though some of the water moves farther in large pores through the profile and carries nitrates with it.

In sandy soils each inch of rainfall moves nitrates down about one foot. If the total rainfall at one time is more than six inches, little nitrate will be left within rooting depth on sands.

Between rains there is some upward movement of nitrates in moisture that moves toward the surface as the surface soil dries out. The result is that the penetration of nitrates is difficult to predict from the cumulative total of rainfall.

When trying to estimate the depth of leaching of nitrates in periods of very intensive rainfall, two points need to be considered. First, the rate at which water can enter the surface of silty and clayey soils may be less than the rate of rainfall, so that much of the water runs off the surface either into low spots or into creeks and ditches. Second, the soil may already be saturated. In either of these cases the nitrates will not move down five to six inches as suggested above.

Corn roots usually penetrate to six feet in Illinois soils. Thus, nitrates that leach three to four feet are well within normal rooting depth unless they reach tile lines and are drained from the field.

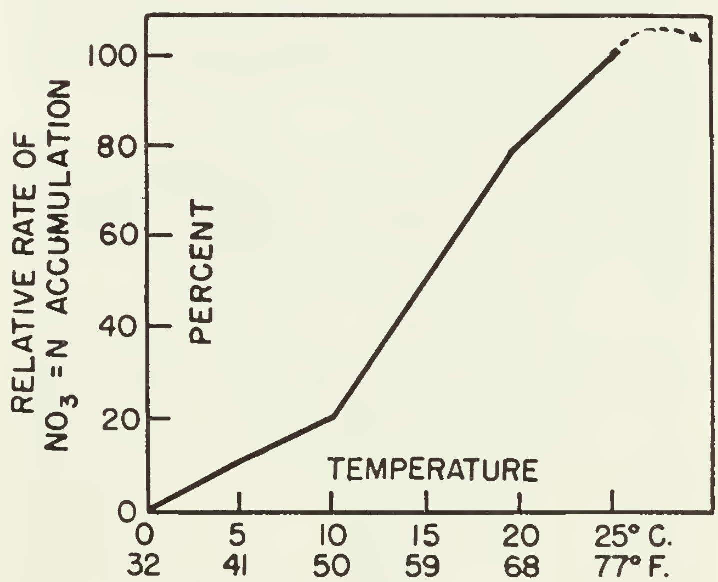
## Time of Application

In recent years farmers in central and northern Illinois have been encouraged to apply nitrogen in the late fall in nonnitrate form any time after the soil temperature at four inches was below 50° F., except on sandy, organic, or very poorly drained soils.

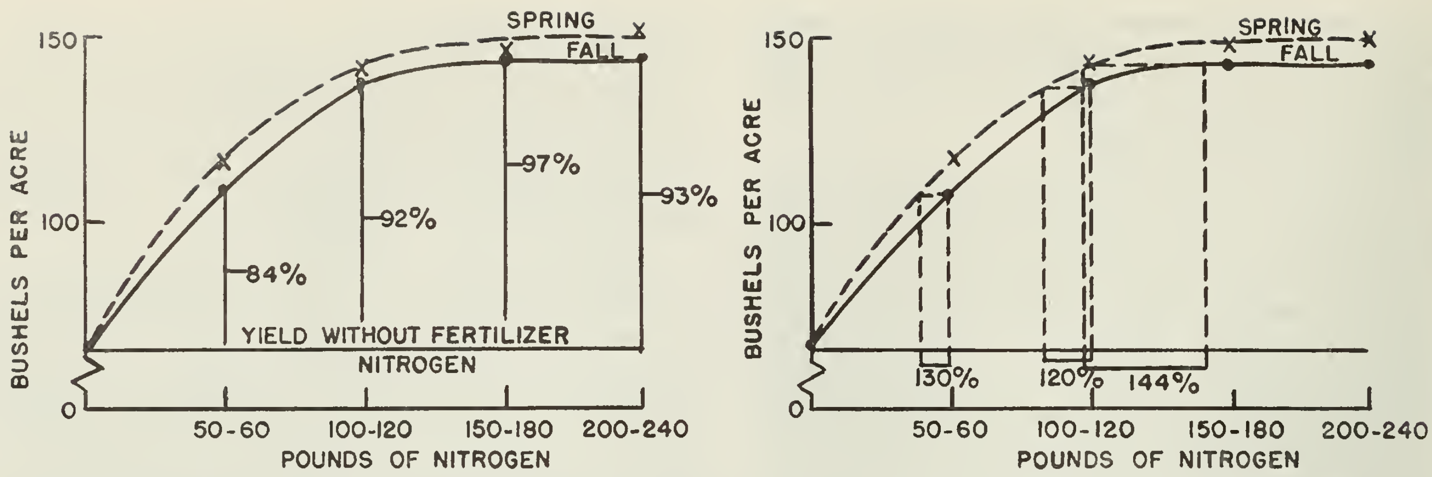
The 50° F. level for fall application is believed to be a realistic guideline for farmers. Applying nitrogen earlier involves risking too much loss (Fig. 8). Later application involves risking wet or frozen fields, which would prevent application and fall plowing. Average dates on which these temperatures are reached are not satisfactory guides to use because of the great variability from year to year. Local dealers and farmers can make good use of soil thermometers to guide fall nitrogen applications.

In Illinois most of the nitrogen applied in late fall or very early spring will be converted to nitrate by corn-planting time. Though the rate of nitrification is slow (Fig. 8), the period of time is long during which the soil temperature is between 32° F. and 40° to 45° F.

The results from 18 experiments in central and northern Illinois in four recent years (Fig. 9) show that fall-applied ammonium nitrate (one-half ammonium, one-half nitrate) was less effective than spring-applied nitrogen. There are two ways to compare efficiency. For example, in Figure 9, left, 120 pounds of nitrogen applied in the fall produced 92 percent as much increase as the same amount applied in the spring. But looked at another way, it required 120 pounds of nitrogen to produce as much yield increase in the fall as was produced by 100 pounds in the spring (Fig. 9, right). At higher nitrogen rates the comparisons become less favor-



**Influence of soil temperature on the relative rate of $NO_3$ accumulation in soils. (Fig. 8)**




**Comparison of fall- and spring-applied ammonium nitrate, 18 experiments in central and northern Illinois, 1966-1969 (DeKalb, Carthage, Carlinville, and Hartsburg). Percentages in figure at left indicate the percentage of increased yield from fall as compared with spring application. Percentages in figure at right indicate the relative amounts of fertilizer you need to apply in the fall to obtain yields equal to those with spring applications.** (Fig. 9)

able for fall application because the yield leveled off six to eight bushels below that from spring application.

Unfortunately, no recent results are available to compare fall, spring, and sidedressed applications of a nitrogen source that is entirely in the ammonium form. The effectiveness of fall-applied nitrogen would likely have been greater if an all-ammonium form had been used. The failure of the highest rate to offset the lower efficiency from fall-applied ammonium nitrate remains an important mystery. Five-year comparisons of spring and sidedressed nitrogen at DeKalb in northern Illinois show that spring and sidedressed applications were equal. In dry years spring application was better. In wet years, sidedressing was better.

In consideration of the date at which nitrates are formed and the conditions that prevail thereafter, the difference in susceptibility to denitrification and leaching loss between late-fall and early-spring applications of ammonium sources is probably small. Both are, however, more susceptible to loss than is nitrogen applied at planting time or as a sidedressing.

Anhydrous ammonia nitrifies more slowly than other ammonium forms and, therefore, is slightly preferred for fall applications. It is well suited to early spring application, provided the soil is dry enough for good dispersion of ammonia and closure of the applicator slit.

**Aerial application.** Recent research at the University of Illinois has indicated that an aerial application of dry urea will result in increased yield. This practice should not be considered as a replacement for normal nitrogen application, but rather as an emergency treatment in instances where corn is too tall for normal applicator equipment. Aerial application of nitrogen solutions on growing corn is not recommended as extensive leaf damage will likely result if the rate of application is greater than 10 pounds of nitrogen per acre.

## Energy Cost and Return

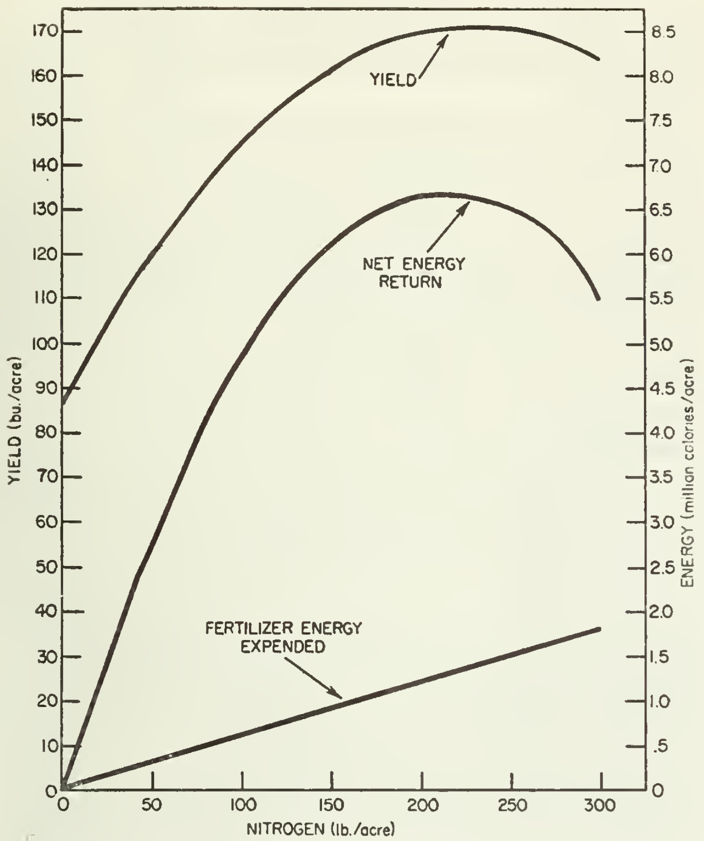
Nearly all inorganic nitrogen fertilizers are the result of combining nitrogen with hydrogen under high pressure and temperature. Ammonia ($NH_3$), the result of this nitrogen-hydrogen combination, can be used directly as a fertilizer or it can be converted chemically to other nitrogen products such as urea, ammonium-nitrate, ammonium phosphates, or nitrogen solutions.

Nitrogen used in fertilizer production is obtained from the air, whereas hydrogen may come from a variety of sources. These include water, natural gas, coal, or oil. At present, natural gas is the primary source of hydrogen for ammonia production in North America because it is the cheapest and most easily obtained source. Shifting from natural gas to heavy oil, which is also in limited supply, would result in an estimated cost increase of approximately 20 percent; a shift to coal as the hydrogen source would increase the cost of ammonia by an estimated 70 percent when the energy costs for the various materials are based on equivalent energy contents.

With the awareness of energy shortages, the use of natural gas to produce nitrogen fertilizer has been questioned. An analysis of the energy cost-return relationship provides a basis for evaluating this question.

The production of one ton of ammonia requires approximately 38,127 cubic feet of natural gas of which 22,219 cubic feet are used to provide hydrogen and the remainder used as an energy source in the process. In addition, it requires nine gallons of fuel oil and 54 Kwh. of electricity to produce one ton of ammonia. This amounts to a total energy expenditure of 6,071 K-cals of energy per pound of nitrogen produced as ammonia.

The production of one bushel of corn results in the storage of 95,000 K-cals of energy. Therefore, a yield increase of 0.064 bushel must be obtained for each pound of nitrogen used to obtain as much energy as was




Fertilizer-energy relationship. (Fig. 10)

expended for the production of the fertilizer. Yield increases in excess of 0.064 bushel per pound of nitrogen will result in net energy production.

Based on research data collected at the University of Illinois Agronomy South Farm from 1968 through 1970, maximum energy return from fertilization was obtained when maximum yield response was approached (Fig. 10). The yield increase obtained from the application of 200 pounds of nitrogen per acre resulted in the production of 6.7 million calories of energy for an investment of 1.2 million calories or net return of 5.6 units of energy for every unit invested.

## Which Nitrogen Fertilizer?

The bulk of the nitrogen fertilizers available for use in Illinois provide nitrogen in the combined form of ammonia, ammonium, nitrate, and/or urea. For many uses on a wide variety of soils, all forms are likely to produce about the same yield increase, provided they are properly applied.

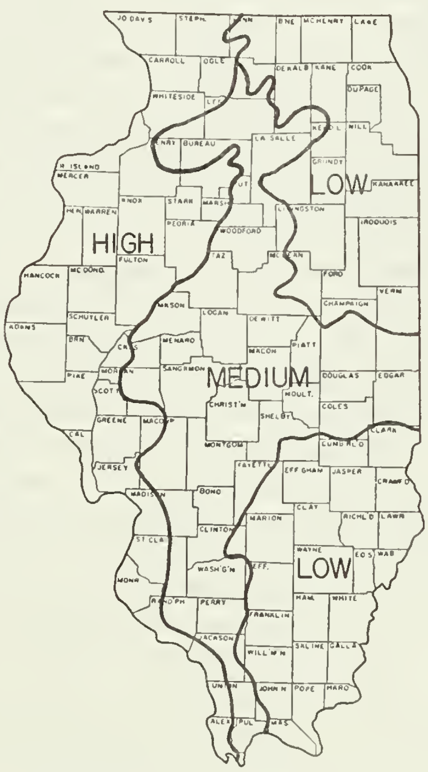
Nitrogen materials that contain free ammonia such as anhydrous ammonia or low-pressure solutions must be injected into the soil to avoid gaseous loss of ammonia. On light-textured (sandy) soils, anhydrous ammonia should be placed eight to ten inches deep, whereas on silt loam soils the depth of application should be six to eight inches. Anhydrous ammonia is lost more easily than ammonia in low-pressure solutions. Nevertheless, these low-pressure solutions do contain free ammonia and need to be incorporated into the soil at a depth of two to four inches. Ammonia should not be applied to soils having a physical condition which would prevent closure of the applicator knife track.

Nitrogen losses from surface-applied materials containing ammonium or amine have been shown to occur. Materials which supply nitrogen in the ammonium form include the ammonium salts of nitrate, phosphate, or sulfate; whereas, amine is supplied from urea or urea-containing solutions.

The loss of nitrogen from ammonium-containing fertilizers applied to Illinois soils is generally negligible. This loss might be of some concern on calcareous soils, but even on these soils, it will be negligible if the materials are incorporated into the soil.

A number of factors influence the rate of nitrogen loss from surface-applied urea. Losses are more probable on high pH soils with low cation-exchange capacity, than on acid soils with high exchange capacity. Presence of a plant residue also increases the likelihood of loss. Most research has also indicated that losses will be more severe if urea is surface applied to dry or drying soils. Incorporation of urea into the soil will reduce volatilization losses to a negligible amount.

Nitrogen materials that contain a significant portion of the nitrogen in the nitrate form, such as ammonium nitrate, potassium nitrate, or calcium nitrate, should not be applied to sandy soils because of likelihood of leach-




Phosphorous-supplying power. (Fig. 11)

ing. Likewise, they should not be applied far in advance of the time the crop needs the nitrogen due to the possibility of loss via denitrification.

## Phosphorus and Potassium

### Inherent Availability

Illinois has been divided into three regions in terms of inherent phosphorus-supplying power of the soil below the plow layer in dominant soil types (Fig. 11).

High phosphorus-supplying power means:

1. The soil test for available phosphorus ($P_1$ test) is relatively high.

2. Conditions are favorable for good root penetration and branching throughout the soil profile.

Low phosphorus-supplying power may be caused by one or more of these factors:

1. A low supply of available phosphorus in the soil profile because (a) the parent material was low in P; (b) phosphorus was lost in the soil-forming process; or (c) the phosphorus is made unavailable by high pH (calcareous) material.

2. Poor internal drainage that restricts root growth.

3. A dense, compact layer that inhibits root penetration or branching.

4. Shallowness to bedrock, sand, or gravel.

5. Drouthiness, strong acidity, or other conditions that restrict crop growth and reduce rooting depth.

Regional differences in P-supplying power are shown in Figure 11. Parent material and degree of weathering were the primary factors considered in determining the various regions.

The "High" region occurs in western Illinois where the primary parent material was more than four to five feet of loess which was high in phosphorus content. The soils are leached of carbonates to a depth of more than 3½ feet, and roots can easily spread in the moderately permeable profiles.

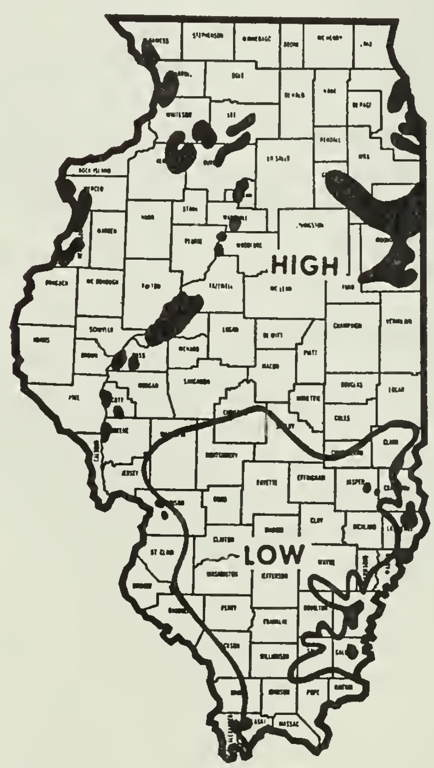
The "Medium" region occurs in central Illinois with an arm extending into northern Illinois and a second arm extending into southern Illinois. The primary parent material was more than three feet of loess over glacial till, glacial drift, or outwash. Some sandy areas with low P-supplying power occur in the region. Compared with the high region, more of the soils are poorly drained and have less available phosphorus in the subsoil and substratum horizons. Carbonates are likely to occur at shallower depths than in the high region. The soils in the northern and central areas are generally free of root restrictions. Soils in the southern arm are more likely to have root-restricting layers within the profile. Phosphorus-supplying power of soils of the region is likely to vary with natural drainage. Soils with good internal drainage are likely to have high available P levels in the subsoil and substratum. If internal drainage is fair or poor, P levels in the subsoil and substratum are likely to be low or medium.

In the "Low" region in southeastern Illinois, the soils were formed from 2½ to 7 feet of loess over weathered Illinoian till. The profiles are more highly weathered than in the other regions and are slowly or very slowly permeable. Root development is more restricted than in the "High" and "Medium" regions. Subsoil phosphorus levels may be rather high by soil test in some soils of the region, but this is partially offset by conditions that restrict rooting.

In the "Low" region in northeastern Illinois, the soils were formed from thin (less than three feet) loess over glacial till. The glacial till, generally low in available phosphorus, ranges in texture from gravelly loam to clay in various soil associations of the region. In addition, shallow carbonates further reduce the phosphorus-supplying power of the soils of the region. High bulk density and slow permeability in the subsoil and substratum restrict rooting in many soils of the region.

The three regions are separated to show broad differences between them. Parent material, degree of weathering, native vegetation, and natural drainage vary within a region and cause variation in phosphorus-supplying power. It appears, for example, that soils developed under forest cover have more available subsoil phosphorus than those developed under grass.

Illinois is divided into two general regions based on potassium-supplying power (Fig. 12). There are, of




**Potassium-supplying power. The black areas are sands with low potassium-supplying power. (Fig. 12)**

course, important differences among soils within these general regions because of differences in the seven factors listed below.

Inherent potassium-supplying power depends mainly on:

1. The amount of clay and organic matter. This influences the exchange capacity of the soil.
2. The degree of weathering of the soil material. This affects the amount of potassium that has been leached out.
3. The kind of clay mineral.
4. Drainage and aeration. These influence K uptake.
5. Very high calcium and magnesium may reduce K uptake.
6. The parent material from which the soil formed.
7. Compactness or other conditions that influence root growth.

Soils having a cation exchange capacity less than 12 me./100 g. are classified as having low potassium-supplying power. These include the sandy soils since minerals from which these soils developed are inherently low in K, as well as the fact that these soils have very low cation exchange capacities and thus do not hold much reserve K.

Silt loam soils in the "Low" area in southern Illinois (claypans) are relatively older soils in terms of soil development and consequently much more of the potassium has been leached out of the rooting zone. Furthermore, wetness and a platy structure between the surface and subsoil may interfere with rooting and with K uptake early in the growing period, even though roots are present.

## Rate of Fertilizer Application

**Buildup.** Certain minimum soil test phosphorus and potassium levels are needed in order to produce optimum crop yields.

Near maximum yields of corn and soybeans will be obtained when available phosphorus levels are maintained at 30, 40, and 45 pounds of phosphorus per acre for soils in the high, medium, and low phosphorus-supplying region. However, since phosphorus will not be lost from the soil system other than through crop removal or soil erosion, and since these are minimum values required for optimum yields, it is recommended that soil test levels be built up to 40, 45, and 50 pounds per acre for soils in the high, medium, and low phosphorus supplying regions respectively. These values insure that soil phosphorus availability will not limit crop yield.

Research has shown that it requires, as an average for Illinois soils, nine pounds of $P_2O_5$ per acre to increase the $P_1$ soil test one pound. Therefore, the recommended rate of build-up phosphorus is equal to: the soil test goal minus the actual soil test value multiplied by nine. The amount of phosphorus recommended for buildup over a four-year period for various soil test levels is presented in Table 46.

**Table 46. — Amount of Phosphorus ($P_2O_5$) Required To Build-Up the Soil (based on build-up occurring over a four-year period; 9 pounds of $P_2O_5$ per acre required to change $P_1$ Soil Test 1 pound)**

| $P_1$ test (lb./acre) | Pounds of $P_2O_5$ to apply per acre *each year* for soils with supplying power of: | | |
|---|---|---|---|
| | Low | Medium | High |
| 4 | 103 | 92 | 81 |
| 6 | 99 | 88 | 76 |
| 8 | 94 | 83 | 72 |
| 10 | 90 | 79 | 68 |
| 12 | 86 | 74 | 63 |
| 14 | 81 | 70 | 58 |
| 16 | 76 | 65 | 54 |
| 18 | 72 | 61 | 50 |
| 20 | 68 | 56 | 45 |
| 22 | 63 | 52 | 40 |
| 24 | 58 | 47 | 36 |
| 26 | 54 | 43 | 32 |
| 28 | 50 | 38 | 27 |
| 30 | 45 | 34 | 22 |
| 32 | 40 | 29 | 18 |
| 34 | 36 | 25 | 14 |
| 36 | 32 | 20 | 9 |
| 38 | 27 | 16 | 4 |
| 40 | 22 | 11 | 0 |
| 42 | 18 | 7 | 0 |
| 44 | 14 | 2 | 0 |
| 45 | 11 | 0 | 0 |
| 46 | 9 | 0 | 0 |
| 48 | 4 | 0 | 0 |
| 50 | 0 | 0 | 0 |

The nine-pound value of $P_2O_5$ to increase soil test one pound is an average value and, as such, this rate of application will result in some soils failing to reach the desired goal in four years and others exceeding the goal. Therefore, it is recommended that each field be retested every four years.

The only significant loss of soil-applied potassium is through crop removal or soil erosion. Therefore, it is recommended that soil test potassium be built up to values of 260 and 300 pounds of exchangeable potassium respectively for soils in the low- and high-cation-exchange capacity region. These values are slightly higher than that required for maximum yield, but as in the phosphorus recommendations this will insure that potassium availability will not limit crop yields.

Research has shown that it requires on the average four pounds of $K_2O$ to increase the soil test one pound. Therefore, the recommended rate of potassium application for increasing the soil test value to the desired goal is equal to: soil test goal minus the actual soil test value

Table 47. — The Amount of Potassium ($K_2O$) Required To Build-Up the Soil (based on the buildup occurring over a four-year period; 4 pounds of $K_2O$ per acre required to change the K test 1 pound)

| K test[1] (lb./acre) | Amount of $K_2O$ to apply per acre *each year* for soils with cation exchange capacity: Low[2] | High[2] |
|---|---|---|
| 50 | 210 | 250 |
| 60 | 200 | 240 |
| 70 | 190 | 230 |
| 80 | 180 | 220 |
| 90 | 170 | 210 |
| 100 | 160 | 200 |
| 110 | 150 | 190 |
| 120 | 140 | 180 |
| 130 | 130 | 170 |
| 140 | 120 | 160 |
| 150 | 110 | 150 |
| 160 | 100 | 140 |
| 170 | 90 | 130 |
| 180 | 80 | 120 |
| 190 | 70 | 110 |
| 200 | 60 | 100 |
| 210 | 50 | 90 |
| 220 | 40 | 80 |
| 230 | 30 | 70 |
| 240 | 20 | 60 |
| 250 | 10 | 50 |
| 260 | 0 | 40 |
| 270 | 0 | 30 |
| 280 | 0 | 20 |
| 290 | 0 | 10 |
| 300 | 0 | 0 |

[1] Tests on soil samples that are taken before May 1 or after September 30 should be adjusted downward as follows: subtract 30 pounds for dark-colored soils in central Illinois; 45 pounds for light-colored soils in central and northern Illinois, and fine-textured bottomland soils; and 60 pounds for medium- and light-colored soils in southern Illinois.

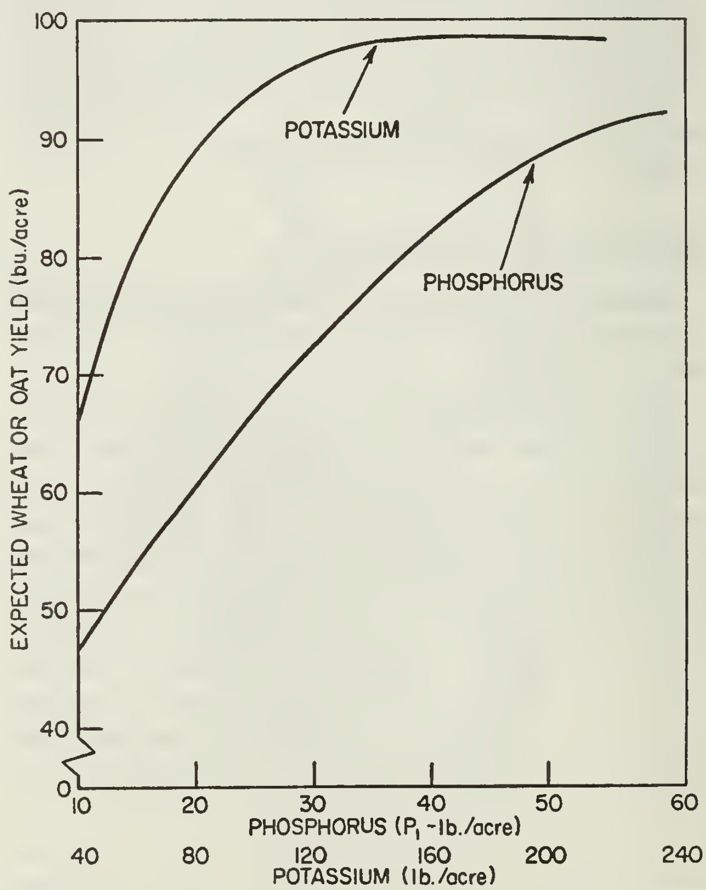
[2] The low cation exchange capacity corresponds to soil areas designated low in potassium-supplying power, while high cation exchange capacity soils are those formerly designated medium to high in potassium-supplying power. Low cation exchange capacity soils would be those with CEC less than 12 me./100 g. soil and high would be those equal to or greater than 12 me./100 g. soil.

multiplied by four. Tests on soil samples that are taken before May 1 or after September 30 should be adjusted downward as follows: subtract 30 for dark-colored soils in central Illinois; subtract 45 for light-colored soils in central and northern Illinois; subtract 60 for medium and light-colored soils in southern Illinois; subtract 45 for fine-textured bottomland soils. Annual potassium application rates recommended for a four-year period for various soil test values are presented in Table 47.

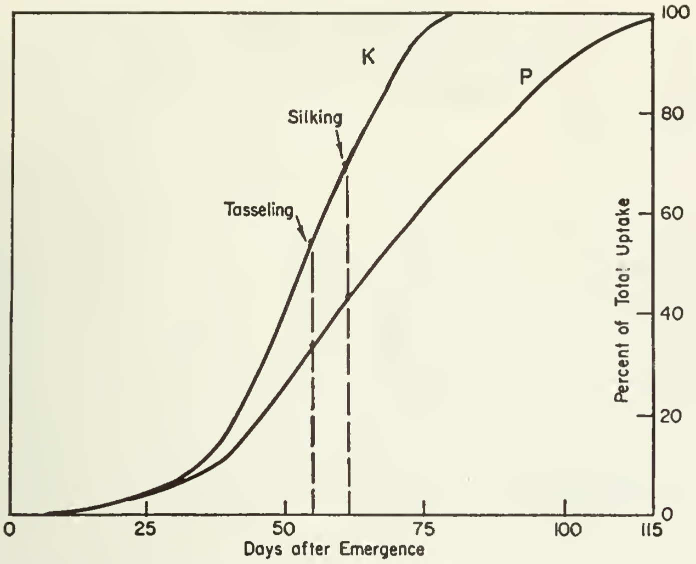
In addition to supplying power of the soil, the optimum soil test value is also influenced by the crop to be grown. For example, phosphorus soil test level required for optimum wheat and oat yield is considerably higher than for corn or soybeans and the optimum level is the same irrespective of phosphorus-supplying ability of the soil (Fig. 13). One reason for this difference in requirement is due in part to the different phosphorus uptake patterns of wheat and corn. Wheat requires a large amount of readily available phosphorus in the fall when the plant root system is feeding primarily from the upper soil surface. Phosphorus is taken up by corn until the grain is fully developed (Fig. 14), so subsoil phosphorus is more important in interpreting the phosphorus test for corn than for wheat. To compensate for the higher phosphorus requirements of wheat and oats, it is suggested that 1.5 times the maintenance application be applied prior to seeding.

Wheat is not very responsive to potassium unless the soil test is less than 100. However, since wheat is usually grown in rotation with corn and soybeans, it is suggested that soils be maintained at the optimum available potassium level for corn and soybeans.

Maintenance. In addition to adding fertilizer to build up the soil test, sufficient fertilizer should be added each year to maintain a specified soil test level. The amount of fertilizer required to maintain the soil test value is equal to the amount removed by the harvested portion of the crop (Table 48). The only exception to this is that maintenance for wheat and oats is equal to 1.5 times phosphate ($P_2O_5$) removal in the grain. This correction




**Relationship between expected wheat or oat yield and soil test phosphorus and potassium. (Fig. 13)**




**Uptake of phosphorus (P) and potassium (K) by corn through the growing season (Hanway, Iowa State University) (Fig. 14)**

has already been accounted for in the maintenance values given in Table 48.

Although it is recommended that soil test levels be maintained slightly above the level at which optimum yield would be expected, it would not be economical to attempt to maintain the values at excessively high levels. Therefore, it is suggested that no fertilizer be applied if $P_1$ soil test values are higher than 60, 65, or 70 respectively for soils in the high, medium, and low phosphorus-supplying regions. Similarly, potassium fertilizer should not be applied if available "K" is higher than 360 and 400 respectively for soils in the low and high cation exchange capacity regions.

Examples of how to arrive at phosphorus and potassium fertilizer recommendations are presented below.

**Example 1.** Continuous corn with a yield goal of 140 bushels per acre:

(a) *Soil test results* / *Soil region*

| Soil test results | Soil region |
|---|---|
| $P_1$ 30 | high |
| K 250 | high |

(b) *Fertilizer recommendation, pounds per acre per year*

| | $P_2O_5$ | $K_2O$ |
|---|---|---|
| Build-up | 22 (Table 11) | 50 (Table 12) |
| Maintenance | 60 (Table 13) | 39 (Table 13) |
| Total | 82 | 89 |

**Example 2.** Corn-soybean rotation with a yield goal for corn of 140 bushels per acre and for soybeans of 40 bushels per acre:

(a) *Soil test results* / *Soil region*

| Soil test results | Soil region |
|---|---|
| $P_1$ 20 | low |
| K 200 | low |

**Table 48. — Maintenance Fertilizer Required for Various Yields of Crops**

| Yield (Bu. or tons per acre) | $P_2O_5$ | $K_2O$ |
|---|---|---|
| | *Pounds per acre* | |
| Corn grain | | |
| 90 bu. | 39 | 25 |
| 100 | 43 | 28 |
| 110 | 47 | 31 |
| 120 | 52 | 34 |
| 130 | 56 | 36 |
| 140 | 60 | 39 |
| 150 | 64 | 42 |
| 160 | 69 | 45 |
| 170 | 73 | 48 |
| 180 | 77 | 50 |
| 190 | 82 | 53 |
| 200 | 86 | 56 |
| Oats | | |
| 50 bu. | 19 | 10 |
| 60 | 23 | 12 |
| 70 | 27 | 14 |
| 80 | 30 | 16 |
| 90 | 34 | 18 |
| 100 | 38 | 20 |
| 110 | 42 | 22 |
| 120 | 46 | 24 |
| 130 | 49 | 26 |
| 140 | 53 | 28 |
| 150 | 57 | 30 |
| Soybeans | | |
| 30 bu. | 26 | 39 |
| 40 | 34 | 52 |
| 50 | 42 | 65 |
| 60 | 51 | 78 |
| 70 | 60 | 91 |
| 80 | 68 | 104 |
| 90 | 76 | 117 |
| 100 | 85 | 130 |
| Corn silage | | |
| 90 bu.; 18T. | 48 | 126 |
| 100; 20 | 53 | 140 |
| 110; 22 | 58 | 154 |
| 120; 24 | 64 | 168 |
| 130; 26 | 69 | 182 |
| 140; 28 | 74 | 196 |
| 150; 30 | 80 | 210 |
| Wheat | | |
| 30 bu. | 27 | 9 |
| 40 | 36 | 12 |
| 50 | 45 | 15 |
| 60 | 54 | 18 |
| 70 | 63 | 21 |
| 80 | 72 | 24 |
| 90 | 81 | 27 |
| 100 | 90 | 30 |
| 110 | 99 | 33 |
| Alfalfa, grass, or alfalfa-grass mixtures | | |
| 2T | 24 | 100 |
| 3 | 36 | 150 |
| 4 | 48 | 200 |
| 5 | 60 | 250 |
| 6 | 72 | 300 |
| 7 | 84 | 350 |
| 8 | 96 | 400 |
| 9 | 108 | 450 |
| 10 | 120 | 500 |

(b) *Fertilizer recommendation, pounds per acre per year*

| | $P_2O_5$ | $K_2O$ |
|---|---|---|
| | *Corn* | |
| Build-up | 68 | 60 |
| Maintenance | 60 | 39 |
| Total | 128 | 99 |
| | *Soybeans* | |
| Build-up | 68 | 60 |
| Maintenance | 34 | 52 |
| Total | 102 | 112 |

Note that buildup recommendations are independent of the crop to be grown, but maintenance recommendations are directly related to the crop to be grown and the yield goal for the particular crop.

**Example 3.** Continuous corn with a yield goal of 150 bushels per acre:

(a) *Soil test results*

| *Soil test results* | *Soil region* |
|---|---|
| $P_1$ 90 | low |
| K 420 | low |

(b) *Fertilizer recommendation, pounds per acre per year*

| | $P_2O_5$ | $K_2O$ |
|---|---|---|
| Build-up | 0 | 0 |
| Maintenance | 0 | 0 |
| Total | 0 | 0 |

Note that soil test values are higher than suggested, thus no fertilizer would be recommended. Retest the soil after four years to determine fertility needs.

For growers planning to double-crop soybeans after wheat, it is suggested that phosphorus and potassium fertilizer required for both the wheat and soybeans be applied prior to seeding the wheat. This practice will reduce the number of field operations necessary at planting time and will thus hasten the planting operation.

The maintenance recommendations for a double-cropped wheat and soybean system for phosphorus and potassium are presented in Tables 49 and 50, respectively. Assuming a 50-bushel per acre wheat yield followed by a 30-bushel per acre soybean yield, the maintenance recommendation would be 71 pounds of $P_2O_5$ and 54 pounds of $K_2O$ per acre.

**Table 49. — Maintenance Phosphorus Required for Wheat-Soybean Double-Crop System**

| Wheat yield (bu./acre) | Soybean yield (bu./acre) | | | | |
|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 |
| | | | $P_2O_5$ (*lb./acre*) | | |
| 30 | 44 | 53 | 61 | 69 | 78 |
| 40 | 53 | 62 | 70 | 78 | 87 |
| 50 | 62 | 71 | 79 | 87 | 96 |
| 60 | 71 | 80 | 88 | 96 | 105 |
| 70 | 80 | 89 | 97 | 105 | 114 |
| 80 | 89 | 98 | 106 | 114 | 123 |

**Table 50. — Maintenance Potassium Required for Wheat-Soybean Double-Crop System**

| Wheat yield (bu./acre) | Soybean yield (bu./acre) | | | | |
|---|---|---|---|---|---|
| | 20 | 30 | 40 | 50 | 60 |
| | | | $K_2O$ (*lb./acre*) | | |
| 30 | 35 | 48 | 61 | 74 | 87 |
| 40 | 38 | 51 | 64 | 77 | 90 |
| 50 | 41 | 54 | 67 | 80 | 93 |
| 60 | 44 | 57 | 70 | 83 | 96 |
| 70 | 47 | 60 | 73 | 86 | 99 |
| 80 | 50 | 63 | 76 | 89 | 102 |

## Time of Application

Although the fertilizer rates for build-up and maintenance indicated in Tables 46 through 47 are for an annual application, producers may apply enough nutrients in any one year to meet the needs of the crops to be grown in the succeeding two- to three-year period.

For perennial forage crops it would be advisable to broadcast and incorporate all of the build-up and as much of the maintenance phosphorus as economically feasible prior to seeding. On low-fertility soils, the application of 30 pounds of phosphate ($P_2O_5$) per acre using a band seeder will likely be advantageous. If a band seeder is used you may safely apply a maximum of 30 to 40 pounds of potash ($K_2O$) per acre in the band with the phosphorus. On a broadcast basis you can safely apply up to 300 pounds of $K_2O$ per acre in the seedbed without damaging seedlings.

Topdress applications of phosphorus and potassium on perennial forage crops may be applied at any convenient time. Usually this will be after the first harvest or in September.

## High Water Solubility of Phosphorus

The degree of water solubility of the portion that is listed as available $P_2O_5$ on the fertilizer label is of little importance for typical field crop and soil conditions on soils with medium to high levels of available phosphorus, when recommended rates of application are used, and with broadcast placement.

There are some exceptions when water solubility is important. These include:

1. For band placement of a small amount of fertilizer that is designed to stimulate early growth, at least 40 percent of the phosphorus should be water soluble for application to acid soils and preferably 80 percent for calcareous soils. The phosphorus in nearly all fertilizers sold in Illinois is at least 50 percent water soluble.

2. For calcareous soils, a high degree of water solubility is desirable, especially on soils that are shown by soil test to be low in available phosphorus.

## Secondary Nutrients

Deficiencies of secondary nutrients (calcium, magnesium, sulfur) have not been identified in Illinois where soil pH is 5.5 or above. However, recognition of sulfur deficiency has been reported with increasing frequency throughout the midwest, focusing greater attention on the importance of this element in plant nutrition. These deficiencies are occurring probably because of (a) increased use of sulfur-free fertilizer; (b) decreased use of sulfur as a fungicide and insecticide; (c) increased crop yields, which results in increased requirements for all of the essential plant nutrients; and (d) decreased atmospheric sulfur supply.

Sulfur deficiency will most likely occur first on highly leached, low-organic-matter sandy soils which are being intensively cropped with plants having a high sulfur requirement such as alfalfa.

## Micronutrients

The elements that are classified as essential micronutrients include zinc, iron, manganese, copper, boron, molybdenum, and chlorine. These nutrients are classified as micronutrients because they are required in small (micro) amounts.

Confirmed deficiencies of these micronutrients in Illinois have been limited to boron deficiency of alfalfa and iron and manganese deficiency of soybeans. A few farmers and fertilizer dealers have reported suspected cases of deficiencies of one or more of these micronutrients, but none has been verified by research trials in Illinois. Research trials are continuing in Illinois to attempt to identify areas of potential deficiency.

Manganese deficiency (stunted plants with green veins in yellow or whitish leaves) is common on high-pH (alkaline), sandy soils, especially during cool, wet weather in late May and June. Suggested treatment is to spray 10 pounds of manganese sulfate (containing 2.5 pounds of manganese) per acre in 25 gallons of water when the beans are 6 to 10 inches tall. If the spray is directed on the row the rate can be cut in half. Some fertilizer dealers have other manganese formulations that you can apply according to instructions. Broadcast application on the soil is ineffective because the manganese becomes unavailable in soils with high pH.

Wayne and Hark soybean varieties often show iron deficiency on soils with a very high pH (usually 7.4 to 8.0). The symptoms are similar to manganese deficiency. Most of the observed deficiencies have been on Harpster, a "shelly" soil that occurs in low spots in some fields in central and northern Illinois. This problem appeared on Illinois farms only since the Wayne variety was introduced in 1964.

Soybeans often outgrow the stunted, yellow appearance of iron shortage. As a result it has been difficult to measure yield losses or decide whether or how to treat affected areas. Sampling by U.S. Department of Agriculture scientists in 1967 indicated yield reductions of 30 to 50 percent in the center of severely affected spots. The yield loss may have been caused by other soil factors associated with very high pH and poor drainage, rather than by iron deficiency itself. Several iron treatments were ineffective in trials near Champaign and DeKalb in 1968. Minnesota, which has had far more experience with iron deficiencies than Illinois, reports that "there is no known solution as yet."

In order to identify areas before micronutrient deficiencies become important, we need to continually observe the most sensitive crops in soil situations where the elements are most likely to be deficient (Table 51).

In general, deficiencies of most micronutrients are accentuated by one of five situations: (1) strongly weathered soils, (2) coarse-textured soils, (3) soils high in pH, (4) organic soils, and (5) soils inherently low in organic matter or low in organic matter because of removal of topsoil by erosion or land-shaping processes.

The use of micronutrient fertilizers should be limited to the application of specific micronutrients to areas of known deficiency. Then apply only the deficient nutrient. An exception to this would be for farmers already in the highest yield bracket to try micronutrients on an experimental basis in fields which are yielding less than expected under good management, which includes an adequate nitrogen, phosphorus, and potassium fertility program.

## Method of Fertilizer Application

**Broadcast and row fertilization.** On high-fertility soils, both maintenance and buildup phosphorus will be efficiently utilized when broadcast and plowed or disked in. However, on low-fertility soils it would be advisable to broadcast the buildup fertilizer and apply the maintenance fertilizer in the row. Farmers in central and northern Illinois who plant early may find it advantageous to apply some row fertilizer for promotion of early vigorous growth in soils that remain cool and wet in early spring.

**Pop-up.** Pop-up fertilizer will make corn look very good early in the season and may aid in early cultivation for weed control. But there is not likely to be a substantial difference in yield produced in most years by a so-called pop-up application or by fertilizer that is placed in a band to the side and below the seed. With these

Table 51. — Soil Situations and Crops Susceptible to Micronutrient Deficiency

| Micronutrient | Sensitive crop | Susceptible soil situations | Season favoring deficiency |
|---|---|---|---|
| Zinc (Zn) | Young corn | 1. Low organic matter either inherent or due to erosion or land shaping<br>2. High pH, i.e. >7.3<br>3. Very high phosphorus<br>4. Restriced root zone<br>5. Coarse textured (sandy)<br>6. Organic soils | Cool, wet |
| Iron (Fe) | Wayne soybeans, grain sorghum | 1. High pH<br>2. Excessively wet | Cool, wet |
| Manganese (Mn) | Soybeans, oats | 1. High pH<br>2. Excessively wet<br>3. Restricted root zone<br>4. Organic soils | Cool, wet |
| Copper (Cu) | Corn | 1. Infertile sand<br>2. Organic soils | Unknown |
| Boron (B) | Alfalfa | 1. Low organic matter<br>2. High pH<br>3. Strongly weathered soils in south-central Illinois | Drouth |
| Molybdenum (Mo) | Alfalfa, soybeans | 1. Strongly weathered soils in south-central Illinois | Unknown |
| Chlorine (Cl) | Unknown | 1. Coarse-textured soils | Excessive leaching by low Cl water |

two placements there will seldom be a difference of more than a few days in the time the root system intercepts the fertilizer band.

Pop-up fertilization means placing 40 to 50 pounds of fertilizer in contact with the seed. Research in many states over a long period of time has shown that, for starter effect only, you should place fertilizer as close to the seed as safety permits. With pop-up fertilizer application, the tube from the fertilizer hopper is positioned to place the fertilizer in contact with the seed. The fertilizer is not mixed with the seed prior to planting.

When applying pop-up fertilizer, it should contain all three major nutrients in a ratio of about 1-4-2 of N-$P_2O_5$-$K_2O$ (1-1.7-1.7 of N-P-K). The maximum safe amount of $N + K_2O$ for pop-up placement is about 10 to 12 pounds per acre in 40-inch rows and correspondingly more in 30- and 20-inch rows. It is, in fact, necessary to apply more in narrow rows in order to have an equal amount per foot of corn row.

The term pop-up is a misnomer. The corn does not emerge sooner than without it, and it may come up one or two days later. It may, however, grow more rapidly during the first one to two weeks after emergence.

Pop-up fertilizer is unsafe for soybeans. In research conducted at Dixon Springs by George McKibben, stand was reduced to one-half by applying 50 pounds of 7-28-14 and to one-fifth with 100 pounds of 7-28-14.

Foliar. The most important and practical use of foliar sprays has been for the application of micronutrients. Micronutrients are required in amounts small enough that the total need of a corn or soybean crop can be applied in one spraying. In addition, deficiency of these micronutrients frequently occurs where soil fixation rapidly reduces the efficiency of usage from a soil application.

Research conducted in the midwest has shown that a foliar application of nitrogen, phosphorus, and potassium does not significantly increase yields when the recommended amount of fertilizer has been applied to the soil. Furthermore, the requirements for nitrogen, phosphorus, and potassium are such that 10 to 20 separate foliar applications would have to be made to provide an adequate amount of these nutrients on a deficient soil and still avoid leaf burn. Most research has indicated that application of more than 10 pounds of nitrogen per acre to the foliage will result in severe leaf burn.

## Fertility "Quacks" Get New Life

It seems hard to believe that in this day of better informed farmers the number of letters, calls, and promotional leaflets about completely unproven products is increasing.

The claim is usually that Product X either: replaces fertilizers and costs less; makes nutrients in the soil more available; supplies micronutrients; or is a natural product that does not contain strong acids that kill soil bacteria and earthworms.

Research is such a magic word that people are conditioned to expect miraculous new products and thus the door is opened for the fertility quack.

The strongest position that legitimate fertilizer dealers, extension advisers, and agronomists can take is to challenge these peddlers to produce unbiased research results to support their claims. Farmer testimonials are no substitute for research. Incidentally, when a legitimate fertilizer company depends heavily upon farmer testimonials in its advertising, the selling job of the quack is made easier.

Agronomists can often refute the specific claims of the quacks on theory and with research results, but then the quacks come up with new claims or fall back on the old cliche, "We don't know why it works, but it does." No one can effectively argue with the farmer who says, "It works on my farm." Dozens of research trials on the same kind of soil are no match for the simple statement, "It works for me." That is what is so frustrating to dealers, agronomists, and extension advisers, and so dangerous to farmers who depend upon farmer testimonials for unproven products.

Extension specialists at the University of Illinois are ready to give unbiased advice when asked either about purchasing new products or accepting a sales agency for them.

## UTILIZATION OF SEWAGE SLUDGE ON AGRICULTURAL LAND

With its nutrient-rich solids, digested sewage sludge can be a valuable resource in crop production. Liquid sludge usually contains 2 to 5 percent solids, while sludge stored in holding lagoons may have lost enough water to be handled as a solid, even with a moisture content of 50 percent or more.

The solids in sludge contain about equal amounts of organic and inorganic materials that include many elements — mainly nitrogen, phosphorus, sulfur, chlorine, carbonate, and metal salts. The carbon:nitrogen ratio is usually about 10:1. Liquid sludge applied 1-inch deep over 1 acre would total 27,000 gallons weighing about 100 tons. If the sludge were 3-percent solids, about 3 tons of dry sludge solids would be spread on the acre, including about 180 pounds of organic nitrogen, 120 pounds of ammonium nitrogen, 180 pounds of phosphorus (411 pounds of $P_2O_5$), and 24 pounds of potassium (30 pounds of $K_2O$).

About a fourth of the organic nitrogen in fresh, liquid sludge incorporated into soil becomes available during the application year. Since sludge loses most of its ammonium nitrogen in drying, nitrogen in dried sludge is mostly in organic compounds.

At the Northeast Agronomy Research Center near Elwood, the University of Illinois has conducted research with liquid sludge on Blount silt loam since 1967. Corn yields have risen as sludge applications have increased. Plots which received annual applications averaging 6.7 dry tons (supplemented by 200 pounds of $K_2O$ per acre) averaged 108 bushels of corn per acre. Control plots which received only annual applications of 240-270-200 inorganic fertilizer yielded 94 bushels per acre over the 7 years. Soybean plots receiving similar amounts of nutrients for 6 years have averaged 34.5 bushels with sludge and 27.7 bushels with inorganic fertilizer. Plots receiving 4 times this amount of sludge showed phosphorus toxicity symptoms in 1972. Sludge applications were suspended, soybean growth was normal in 1973, and yields have recovered.

Sludges vary greatly in their suitability for agricultural land. University of Illinois research indicates that heated, anaerobically digested sludge can be used safely on agricultural land. Few, if any, crop production or environmental problems are likely to result if annual rates of application do not exceed that required to provide sufficient nitrogen and phosphorus for grain crops. The nitrogen content of fresh, liquid digested sludge will determine the initial application rate. If sludge is applied on the same land over many years, the phosphorus or trace element content of the sludge, or both, may determine the long-term application rate.

# SOIL MANAGEMENT AND TILLAGE SYSTEMS

## Water Erosion Control

Bare soils with long slopes have a high potential for water erosion with the rainfall patterns that occur in Illinois. The damage of erosion depends upon soil characteristics. If a soil has horizons in the profile that are unfavorable for root development, water erosion can cause permanent soil damage even though the nutrients lost through erosion can be replaced through liming and fertilization. On soils that are free of root-restricting horizons, water erosion damage is the result of nutrient removal to a large extent. The nutrients can be replaced through application of limestone and fertilizers, but result in added production costs. Reducing nutrient loss through erosion control will help provide for more effective utilization of mineral resources and of the energy used in manufacturing fertilizers.

Soil particles that are eroded must be deposited eventually. Part of the deposition is in streams, lakes, or reservoirs, so water resource quality is lowered.

Effective erosion control systems usually include one or more of three features. First, the soil is protected with a cover of vegetation, such as a mulch of crop residues, as much of the time as possible. Second, the soil is tilled so that a maximum amount of water is absorbed with a minimum of runoff. Third, long slopes are divided into a series of short slopes so that the water cannot get "running room."

Terraces control excessive erosion because they divide long slopes into several short slopes. Strip cropping provides season-long vegetative cover on half or more of a slope and also divides a slope into shorter slope lengths.

Effective erosion-control systems must be designed for a particular situation. Contact your district conservationist with the Soil Conservation Service for technical assistance on erosion-control systems.

Conservation tillage systems protect the soil surface with crop residue and also provide for increased water infiltration and reduced runoff compared with conventional systems.

## Conservation Tillage

Conservation tillage systems provide for control of wind and water erosion and for an increase in the effective supply of water for crops. Conservation tillage changes the soil environment. The most visible changes in the soil environment due to conservation tillage are: (a) changes in surface roughness, and (b) changes in the cover of crop residues on the soil surface relative to conventional tillage. The trademark of conventional tillage is a uniform, smooth, vegetation-free surface. In conservation tillage, the surface microtopography is characteristically rough and porous, and protected with at least a partial cover of crop residues.

## Soil Roughness

After primary tillage, the tilled zone is more porous, is thicker because of the loosening or "fluffing" effect of primary tillage, and can hold more water at saturation than the untilled soil. The surface of the soil is rougher and provides "more" depressions for trapping drifting soil and for temporary detention of water. Secondary tillage with disk and harrow and weathering produce a smooth soil surface that has reduced infiltration, increased runoff, and increased erosion from wind and water. The success of wheel track and other reduced tillage systems in relation to water conservation depends upon the maintenance of a rough water-receptive surface.

Soil roughness also influences soil temperature. A rough surface has more surface area exposed to solar radiation. On soils with stable structure, fall plowing after corn results in higher soil temperatures in the

**Table 52. — Effect of Tillage Operations and Time on the Quantity of Residues on the Soil Surface[a, b]**

| Tillage system | Corn residues on soil surface | | | | | |
|---|---|---|---|---|---|---|
| | Nov. 3 | Nov. 11 | April 19 | May 3 | June 12 | June 16 |
| | *Tons per acre* | | | | | |
| Fall chop and plow | 2.76 | 0 | 0 | 0 | 0 | 0 |
| Fall disk + twisted chisels | 2.76 | 2.28 | 2.18 | 1.31 | 1.51 | 1.43 |
| Fall coulter + twisted chisel | 2.76 | 2.19 | 1.43 | 1.09 | 1.67 | 2.08 |
| Fall chop + chisel | 2.76 | .78 | .49 | .86 | .96 | .79 |
| Spring chop, disk, plow | 2.76 | 2.76 | 2.73 | .00 | .00 | .00 |
| Spring chop + disk | 2.76 | 2.76 | 2.73 | .98 | 1.63 | 1.68 |
| Effect due to | Complete stalk cover | Fall tillage; high wind after chopping | Decomposition over winter | Spring tillage and planting | Application of $NH^3$ | Cultivation |

[a] Unpublished data. Departments of Agric. Eng. and Agronomy, Univ. Ill.
[b] Fall, 1971–Spring, 1972. Flanagan silt loam.

spring than fields on which plowing is delayed until spring. If the structure is unstable so that the soil surface loses its roughness over winter, soil temperature will not be influenced by fall plowing. Low-organic-matter soils and all soils after soybeans are examples. Rough, chiselled soybean fields are likely to retain the surface roughness over winter and will benefit from the surface roughness effect on soil temperature.

## Crop Residue Management

Tillage influences the crop residues on the soil surface. The residues may be buried by plowing them under or may be partially incorporated with a chisel, disk, or in planting. Later tillage operations such as subsurface fertilizer application or cultivation for weed control may uncover partially buried surface residues. The post-planting operations are less likely to significantly increase the amount of residues on the surface if they are chopped before incorporation or are buried by plowing. The effect of tillage operations and time on the quantity of residues on the surface is shown in Table 52.

## Conservation Tillage Reduces Soil and Water Losses

The rough, mulch-covered soil surface reduces runoff and soil erosion. The mulch intercepts rain drops and slows water runoff. The rough soil surface traps water in small depressions. The result is less runoff, more water intake, and less soil erosion.

The influence of conservation tillage systems on soil and water losses is shown in Table 53. Runoff was reduced as much as two inches. Soil loss with conservation tillage was reduced by as much as 87 percent compared with fall plowing.

## Soil Temperature

Crop residues protect the soil from raindrop energy. They also insulate the soil from the sun's energy. As a result, soil temperature is modified by tillage. An example of the effect of tillage on four-inch soil temperature is given in Table 54.

Minimum four-inch soil temperatures occur between 6:00 and 8:00 a.m. The temperatures increased from mid-April through May. Tillage treatment did not have much influence on the minimum soil temperatures.

Maximum four-inch soil temperatures occur between 3:00 and 5:00 p.m. during April and May. April maximum soil temperatures did vary with tillage treatment. During May the fall plow treatment had soil temperatures 3 to 5 degrees warmer than those covered with a mulch of corn stalks.

For late April and early May corn planting, soil temperatures were as favorable for planting with one tillage system as with another. The primary effect of tillage on soil temperature occurs from May until the corn forms a canopy to shade the soil surface. During May and early June, the lower soil temperatures with a mulch are accompanied by slower growth of corn and soybeans. The growth differences will be greatest in years with normal to below normal rainfall. In dry years, little difference in early growth may be seen.

## Tillage Systems and Fertilizer Use

Lime and fertilizer are uniformly mixed in the plow layer with conventional tillage. With chisel, disk, and zero tillage, less mixing of the soil takes place. This results in concentration of nutrients on or near the soil surface. The effects of plow, chisel, and zero tillage sys-

**Table 53. — Conservation Tillage Reduces Soil and Water Losses[a, b]**

| Tillage system | Run-off, inches of water | Soil loss, tons/acre |
|---|---|---|
| Fall plow — spring disk + harrow — plant | 5.7 | 8.3 |
| Fall disk + chisel — spring disk + sweep — plant | 4.1 | 2.3 |
| Fall coulter — chisel — spring field cultivate — plant | 3.7 | 1.9 |
| Fall chop — chisel — spring disk — plant | 4.0 | 3.2 |
| Zero-till (spring chop — plant) | 5.1 | 1.1 |
| Spring disk — plant | 4.0 | 1.7 |

[a] Ten inches water applied at 2.5 inches per hour.
[b] Catlin silt loam, 5 percent slopes.

**Table 54. — Tillage System Influence on Soil Temperature, Four-Inch Depth, Flanagan Silt Loam, Urbana, 1973**

| Week ending | Fall plow | Fall chop-chisel | Spring disk | Zero till |
|---|---|---|---|---|
| | | *Degrees Fahrenheit* | | |
| Minimum soil temperature[a] | | | | |
| April 14 | 39 | 38 | 40 | 40 |
| 21 | 47 | 47 | 48 | 47 |
| 28 | 49 | 50 | 50 | 51 |
| May 5 | 48 | 50 | 47 | 47 |
| 12 | 54 | 53 | 52 | 55 |
| 19 | 53 | 52 | 51 | 51 |
| 26 | 61 | 60 | 60 | 59 |
| Maximum soil temperature[b] | | | | |
| April 14 | 47 | 47 | 47 | 46 |
| 21 | 51 | 51 | 52 | 50 |
| 28 | 56 | 56 | 56 | 56 |
| May 5 | 56 | 53 | 53 | 53 |
| 12 | 60 | 57 | 58 | 57 |
| 19 | 61 | 58 | 59 | 56 |
| 26 | 68 | 65 | 66 | 63 |

[a] Average of daily minimum temperatures, four replications.
[b] Average of daily maximum temperatures, four replications.

**Table 55. — Effect of Tillage System on pH, $P_1$, and K Soil Tests[a, b, c]**

| Depth, inches | Plow | | | Chisel | | | Zero-till | | |
|---|---|---|---|---|---|---|---|---|---|
| | pH | $P_1$ | K | pH | $P_1$ | K | pH | $P_1$ | K |
| 0–1....... | 5.6 | 76 | 455 | 4.9 | 256 | 824 | 4.8 | 408 | 1,020 |
| 1–2....... | 5.6 | 78 | 420 | 5.0 | 276 | 776 | 4.8 | 364 | 672 |
| 2–3....... | 5.7 | 76 | 372 | 5.6 | 231 | 712 | 5.2 | 61 | 552 |
| 3–6....... | 5.7 | 98 | 444 | 6.0 | 75 | 568 | 6.2 | 24 | 428 |
| 6–9....... | 5.6 | 84 | 486 | 5.6 | 24 | 388 | 6.4 | 16 | 296 |
| 0–9....... | 5.6 | 86 | 449 | 5.6 | 118 | 576 | 5.4 | 106 | 491 |

[a] Sampled Fall, 1971 following 4 annual applications of 240 + 120 + 120.
[b] Plow: chop stalks-fall plow-spring disk + harrow-plant-cultivate.
Chisel: chop stalks-fall chisel-spring disk + harrow-plant-cultivate.
Zero till: chop stalks in fall-plant.
[c] Proctor silt loam.

tems on pH, available P, and available K are shown in Table 55.

With the plow system, pH, P, and K tests were rather uniform throughout the plow layer. With the chisel system, pH was lower in the upper two inches than in the 2- to 9-inch layer. P and K were concentrated in the upper three inches. With zero till, the corn is planted in a slit in the soil without any other soil manipulation. Available P and K are concentrated in the upper inch or two.

Corn yields increase with the application of P and K if the soil is deficient in these nutrients (Table 56). However, the yield increases were about the same with plow, chisel, and zero tillage systems. It does not appear that the lack of uniformity of P and K with chisel, zero-till, or other conservation tillage systems should limit the adoption of these systems.

Low pH in the top one or two inches may result from surface applications of nitrogen in chisel and zero till systems (Table 55). To prevent the development of low pH layers at shallow depths, limestone may need to be applied more frequently with conservation tillage than with conventional tillage.

Surface application of nitrogen may be partially tied up by soil organisms that decompose the crop residues on the soil surface in chisel, zero, and other conservation tillage systems. Greater infiltration may cause deeper leaching with conservation tillage systems. Higher soil moisture under a mulch may result in greater denitrification losses. As a result of these factors, nitrogen may be used less efficiently than with conventional tillage. Fifteen to 20 percent more nitrogen may be necessary to make up the difference. Side dressing may give improved nitrogen efficiency by placing the nitrogen below the soil surface and avoiding residue tie-up problems.

**Table 56. — Effect of Tillage System on Response of Corn to Phosphorus and Potassium Fertilizers[a, b]**

| $N + P_2O_5 + K_2O$ lb./acre/year | Fall plow, spring disk + harrow, plant, cultivate | Fall chisel, spring disk + harrow, plant, cultivate | Zero-till, chop stalks in fall, plant |
|---|---|---|---|
| | *Continuous corn, bushels per acre* | | |
| 240 + 0 + 0............... | 131 | 128 | 126 |
| 240 + 60 + 60............ | 142 | 140 | 142 |
| 240 + 120 + 120.......... | 144 | 144 | 150 |
| 240 + 180 + 180.......... | 139 | 145 | 148 |
| Average.................. | 139 | 138 | 142 |

[a] 1970-73, Urbana.
[b] Proctor silt loam.

## Tillage System and Weed-Control Interactions

Weed problems may be acute where heavy corn residues are left on the surface. Several factors contribute to the problem.

First, the weed seeds are left on or near the surface with mulch and zero-tillage. With conventional tillage, the weed seeds are incorporated so that many are too deep for germination and emergence. They may eventually rot.

Second, the corn residues intercept the herbicides and prevent them from reaching the soil where they are most effective.

Third, the corn residues serve as a mulch and reduce evaporation. The soil at or near the surface has sufficient moisture for weed-seed germination. With conventional tillage the soil at the surface may be dry a higher percentage of the time so that the shallower weed seeds do not have sufficient moisture for germination.

With mulch and zero tillage it is especially important to select herbicides on the basis of the type of vegetation which is or will be present. The following suggestions may help you solve a weed problem with mulch or zero tillage. For rates and use suggestions, see pages 58 to 73.

For existing grass-sod vegetation, perennial grasses, and early emerging annual weeds, apply Paraquat at 1 quart per acre for a quick kill at planting time.

For corn, herbicides such as AAtrex, Bladex, Princep, or Lasso may be used alone or in approved combinations for preemergence control.

Where deep-rooted perennials such as alfalfa must be controlled, Paraquat may not be effective since it may kill the tops but allow regrowth from the roots. Herbicides such as 2,4-D or Banvel which can move to the roots may control some of these perennial broadleaf plants. However, they should be applied a few days before the Paraquat to allow time for movement to the roots.

For control of broadleaf weeds that escape the initial treatment in corn, 2,4-D, Banvel, or a combination of the two can be used postemergence.

For annual grasses that cannot be controlled with cultivation, directed postemergence herbicides such as Lorox or Evik may be considered if there is sufficient height difference between the corn and weeds.

For information on weed control for double-crop soybeans, refer to the weed control section of this handbook.

The most effective weed control is achieved when the control measures are adapted for each situation. Watch for developing weed problems and be prepared to take corrective action as needed. Postemergence application of herbicides and row cultivation where feasible may mean the difference between success and failure of the tillage system.

## Tillage and Insect Control

Damage from cornborer, common stalk borer, and other insects may be associated with cornstalk residues or grassy weed infestations, or both, in mulch-tilled and zero-tilled corn. In general, control measures with these tillage systems have not differed from those used with conventional tillage. Careful attention to the developing crop may help you recognize a potential insect problem soon enough for effective control. Specific recommendations are available in Illinois Extension Circular 899, "Insecticide Recommendations for Field Crops."

## Tillage and Disease Control

Tillage systems can and do influence plant disease control. Clean tillage results in incorporation of the residues of the previous crop. The incorporated residue is then subject to biochemical decomposition. Disease-infected residue may be removed through decay. Clean tillage aids soil sanitation. Volunteer corn is more likely to be a problem if residues are left on the surface than if all residues are incorporated. If the volunteer corn is from disease-susceptible hybrids, it may provide for early infection for diseases such as southern corn leaf blight. Although the plant disease potential may be greater with mulch tillage than with clean tillage systems, the erosion control benefits of mulch tillage are great and this benefit needs to be balanced against the disease potential. The use of resistant hybrids and varieties provides an effective tool to minimize plant disease problems. Modification of crop sequence and tillage practices may be used as desired to provide additional control if a disease problem appears very likely.

## Planting Tips for Conservation Tillage

Next to weed control, the most difficult problem with conservation tillage is in obtaining satisfactory stands. The following tips may help.

1. Use a conservation tillage planter. It should be equipped with coulters, sweeps, etc., to cut through crop residues or push them from the row area. The planter should provide for opening a slit in the soil, dropping the seed, and covering and firming the seed in the soil. With less tillage, more weight in and on the planter may be necessary for penetration.
2. Check planter setting carefully and frequently. Plant deep enough to have seed in contact with moist soil. Shallower planting than with conventional tillage is possible, especially with zero tillage.
3. In heavy trash, especially wheat stubble or clover meadow, use treated grain for mouse control.
4. Check corn during and after emergence for signs of cutworm and other insect damage.
5. Plant 15 to 20 percent heavier to provide some stand insurance.

Special care with conservation tillage will help improve your chances of avoiding problems with poor plant population.

## Effect on Crop Yields

Crop yields are generally comparable with different tillage systems if weed control and plant population are adequate on all treatments. Exceptions to this general rule are: (a) on dark-colored, poorly drained soils in central and northern Illinois and (b) soils with root-restricting layers or drouthy soils. Corn yields from several experiments are given in Table 57. Brief soil descriptions are given in the next four paragraphs.

Symerton silt loam is a dark-colored soil with good internal drainage. It is free of root restricting horizons in the upper 3½ to 4 feet. Proctor silt loam has similar profile characteristics. Corn yields with fall plow, chisel, and zero-till systems have been almost the same.

**Table 57. — Corn Yields With Plow, Chisel, and Zero Tillage Systems, Continuous Corn**

| Tillage system | Elwood – Symerton silt loam (1971-73) | Urbana – Drummer silty clay loam (1968-71) | Urbana – Proctor silt loam (1970-73) | Brownstown – Cisne silt loam (1971-73) | Dixon Springs – Grantsburg silt loam (1967-73) |
|---|---|---|---|---|---|
| Fall plow – disk – plant | 116 | 136 | 139 | .. | .. |
| Spring plow – disk – plant | 116 | .. | .. | 104 | 111 |
| Spring plow plant | .. | .. | .. | 103 | 119 |
| Fall chisel – plant | 118 | 132 | 138 | .. | .. |
| Zero-till | 116 | 100 | 142 | 107 | 121 |

Drummer silty clay loam is a dark-colored, poorly drained soil. The plow layer is sticky and compacts easily if tilled when wet. A cornstalk mulch with chisel or zero tillage results in slow early growth and consistently lower yields than with fall plowing and continuous corn.

Cisne silt loam is a claypan soil in south central Illinois. The mulch of cornstalks with zero tillage helps conserve soil moisture. As a result, corn in a zero-till system is less subject to moisture stress than conventionally tilled corn. Yields in dry years are often higher than those obtained with plow tillage systems.

Grantsburg is a light-colored, sloping soil that is common in southern Illinois. A fragipan at 2 to 2½ feet limits rooting. Moisture conservation with a cornstalk mulch in zero tillage often results in higher corn yields.

Research with soybeans and different tillage systems is currently underway in Illinois. Corn yields after soybeans do not appear to be limited with a mulch of soybean residues. With soybeans after corn, satisfactory yields have been obtained with chisel, zero-tillage, and other conservation tillage systems if weed control and stand are adequate.

Moisture-conserving effects of conservation tillage, especially zero tillage, are especially important with double-crop soybeans after wheat. Planting directly in the wheat stubble minimizes evaporation of soil moisture. The risk of delayed emergence due to inadequate soil moisture is reduced.

## Tillage System Combinations

Tillage systems must be designed for a particular situation if they are to be most effective. A system that combines features of one or more of the systems described above may be the best bet to cope with the varying soil and crop-residue situations that exist on most farms. For example, a chisel plow, disk in the spring, or zero tillage may be used following soybeans to control wind erosion. If the soils are level and poorly drained, fall plowing with a moldboard plow may be used to minimize early growth problems with corn following corn.

## Fall Tillage

Chopping stalks, disking, plowing, or chiseling in the fall may help you get off to an early start the following spring. Fall tillage may also present problems if the hazards of wind and water erosion are not considered.

The kind and amount of fall tillage that is needed or desirable depends on the soil, slope, and previous crop, as well as on the seasonal demand for labor and machinery. Of course, weather conditions will have a major role in determining how much tillage is possible before freeze-up late in the fall or early winter.

## The Previous Crop

The previous crop influences the kind and amount of residues that are left after harvest.

Corn residues are the heaviest in terms of tonnage and probably present the greatest problems. Shredding the stalks, or disking followed by fall plowing, or both operations, provide a bare soil surface over winter that may dry earlier in the spring. If the corn stover is not plowed in the fall, leaving the stalks standing without chopping or disking them may provide more wind erosion control than if stalks are shredded. Shredding may protect more of the soil surface against the beating action of rain and thus reduce water erosion. However, the shredded corn residues may mat down and result in wetter soils that dry more slowly in the spring.

Soybean residues are light in tonnage and present essentially no problem in handling. Fall plowing of soybeans will increase the potential for severe wind erosion. Disking soybean fields in the fall will also create a severe wind-erosion problem. The surface soil is loose following soybeans and this, combined with the small amount of residues, results in a potentially severe wind-erosion hazard. Following soybeans, crop yields with spring tillage (plow, disk, chisel, or no-till) have been as good as those with fall plowing in tests in Illinois and Iowa.

Small-grain residues may be plowed in late summer or early fall in preparation for fall seedings of wheat or alfalfa-grass mixtures or for corn or soybeans the following year. Plowing under weeds in the stubble will help reduce weed populations if stubble is plowed before weed seeds mature.

If legume seedings (for green manure) are made in the small grain, more nitrogen will be added by the legume if fall plowing is delayed until late fall (October 15 in northern Illinois, November 15 in southern Illinois). Late fall plowing of meadow crops will also provide additional time for nitrogen fixation by the legume. Grass, grass-legume, or legume meadows that are fall-plowed are less erosive than fall-plowed corn, small grain, or soybeans.

## The Soil

Fall plowing decreases tillage problems on poorly drained soils that have high organic matter and silty clay or silty clay loam surface layers. These soils are usually wet in the spring and will develop poor physical conditions if tilled when too wet. If such soils are fall-plowed, large clods will slake down over winter so that spring seedbed preparation is much easier. *However, avoid fall plowing after soybeans on these soils because of the wind-erosion hazard.*

Dark-colored silt loam soils that are nearly level and have good to fair drainage present fewer tillage problems than the finer textured silty clay loams or silty clay soils.

Fall plowing may be desirable to help spread the labor load or because these soils occur in an intricate pattern with soils that are directly benefited by fall plowing.

Silt loam soils that have less than 2½ percent organic matter are likely to crust during the winter. (The publication, "Color Chart for Estimating Organic Matter in Mineral Soils in Illinois," AG-1941, can be used to estimate organic matter content of the surface soils.) Spring tillage with moldboard plow, chisel plow, or disk, or zero tillage provide alternatives to fall plowing on low-organic-matter soils.

Sandy soils are subject to severe wind erosion if they are fall-plowed, and should be left with a vegetative cover as much of the time as possible.

## Slope

The erosion hazard from fall plowing increases with percent and length of slope. Slopes of less than 2 percent can be safely fall-plowed, although soil erosion can be severe if they are more than 300 feet long and if spring rainfall is above normal in quantity and intensity. Soils with favorable subsoils on slopes of 2 to 4 percent can be fall-plowed on the contour if slope length is less than 150 feet. Longer slopes can be divided into a series of short slopes by leaving an unplowed strip a few feet wide every 150 feet. Severe erosion can occur on soils with unfavorable subsoils even on slopes of 2 to 4 percent.

## Fall Disking

Disking cornstalks may aid fall plowing or chiseling. On soils that are too sloping for safe fall plowing, disking in the fall will incorporate part of the residues, loosen the soil, and result in earlier drying in the spring. Earlier seeding of oats or corn may be possible. Wind erosion will be slightly worse if cornstalks are disked in the fall. *Avoid disking in the fall following soybeans because of the danger of wind erosion.*

## Fall Chiseling

Fall chiseling is a practice used by many farm operators who have developed tillage systems built around the chisel plow. Fall chiseling of cornstalks leaves part of the residue on the surface for wind and water erosion control. The soil is loosened so it dries earlier in the spring than if the field was untilled over the winter. Fall chiseling is especially important where the chisel plow system is used on dark-colored, poorly drained soils. Delays in spring operations or excessive drying often result if all chiseling is delayed until spring. The rough surface left after chiseling of soybean fields in the fall provides a barrier to soil blowing and reduces the hazard of wind erosion. The rough, chiseled surface is most effective if the chisel operation is carried out perpendicular to the prevailing wind.

## Fall-Seeded Cover Crops

Fall seedings of spring oats provide effective control of wind and water erosion if they can be made early enough in the fall for the seeding to be established. The oats should germinate and make sufficient growth for soil protection if seeded by October 1 in the northern one-third of Illinois, by October 15 in the central one-third of Illinois, and by November 1 in the southern one-third of Illinois. Seed directly on fall-plowed fields or on soybean stubble at a rate of 1 to 1½ bushels per acre. Oats will be winter-killed. Seedbeds can be prepared with disk and harrow in spring. Fall-seeded rye can also be used as a winter cover and may provide some spring pasture. It may be necessary to use a contact herbicide such as Paraquat to kill the rye in spring in zero-tillage systems.

## Summary

Fall tillage can help you get the jump on spring field work if you fit it to your cropping situation and your soil and slope conditions. By using fall tillage where it will benefit you and by avoiding fall tillage where wind and water erosion may be severe, you will have a good foundation on which to develop your tillage program.

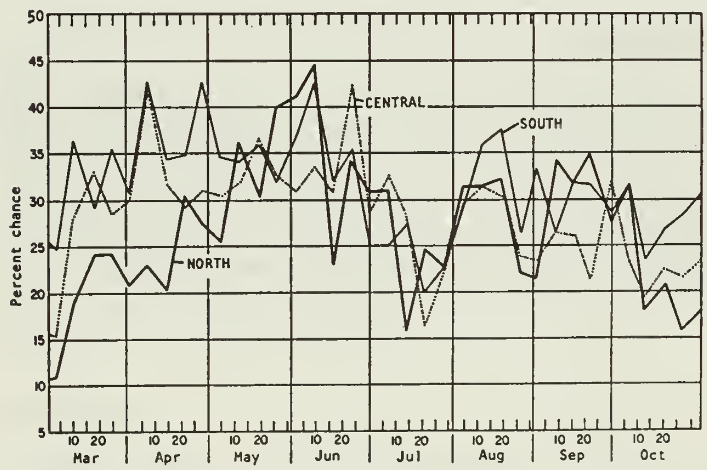
Normally, every section of Illinois receives annually as rain and snow more water than is evaporated from the soil and transpired from plants in that section during the year. Nevertheless, there is never a year when soil moisture is not deficient for optimum plant growth sometime during the growing season.

In an "average" year, potential evapotranspiration (P.E.T.) exceeds precipitation from May to September. Crops grow during this period if one or more of the following conditions prevail: (a) stored soil moisture is sufficient to make up the deficit during the growing period; (b) evapotranspiration (E.T.) is reduced appreciably below potential (P.E.T.); or (c) additional water is added by irrigation.

Crops growing on deep soil with high water-holding capacity (fine texture and high organic matter content) may get by quite well if precipitation is not appreciably below normal and if the soil is filled with moisture at the beginning of the season. E.T. can be reduced by getting fast early growth to help shade the soil, or by mulching. When soil moisture is limiting, E.T. is reduced, but yield reductions usually result from this. Below-normal rainfall periods in the summer are usually also periods of above-normal temperatures, and soil moisture may become severely limiting during such times.

## Rain Probability

The probability of getting 1 inch or more of rain per week is shown in Figure 15. The probability is lowest in




**Chance of one inch or more rain in one week. (Fig. 15)**

all sections of Illinois during the last half of July — a critical period when corn and soybeans are pollinating and setting seed.

One inch of rain per week is not sufficient to replace E.T. losses during the summer but will keep moisture from severely limiting crop growth on soils with reasonably good moisture-holding capacity. Irrigation can be particularly valuable in supplying additional moisture needed during critical periods when rainfall is inadequate. The need for frequent moisture additions is greatest in sandy soils with low moisture-holding capacity. A high proportion of irrigation development in Illinois has taken place in these areas.

## Whether to Irrigate

The decision whether or not to irrigate in Illinois must be based on many factors. The primary consideration is the value of the expected yield increase compared to the anticipated costs. Soil characteristics, cropping pattern, water supply, labor supply and cost, fuel availability and cost, equipment needs and cost, and the availability, cost, and alternative uses of capital are also important factors to consider.

Studies in Illinois from 1955 to 1965 showed that irrigation would increase corn yields about 30 bushels per acre per year on deep, fine-textured soils. Since irrigation costs, both fixed and variable, totaled about 30 dollars per acre in 1969, there was little financial incentive for irrigating corn on the better soils. With corn selling for about three times the price it did in those years, however, the cost:return ratio is much more favorable for irrigation even though annual costs of irrigation probably are now nearly double those in 1969.

Recently we started irrigation studies on corn, soybeans, and vegetable crops on sandy soil in Mason County. Corn yields of 178 bushels and soybean yields of 60 bushels per acre were obtained in 1974 from irrigation applied once per week. Adequate fertilization as well as weed, insect, and disease control practices were followed. There was no unirrigated check plot in 1974, but we are confident that irrigation contributed at least 60 bushels of corn and 20 bushels of soybeans per acre. Check yields will be obtained in 1975 and after.

Serious, careful consideration of the water supply available must precede a decision to irrigate. Assistance can be obtained from the Illinois State Water Survey and the Illinois State Geological Survey in Urbana regarding surface and ground water resources. Extension specialists in Agricultural Engineering and Agronomy, and irrigation equipment dealers can provide assistance regarding feasibility of irrigation and methods and equipment to use. Generally, in the southern part of the state, the sites where wells with adequate capacity can be developed are adjacent to streams. A good rule is to have a well capacity of 10 gallons per minute for each acre if you irrigate 24 hours per day.

Surface impoundment of water is feasible in many areas, but sites with adequate storage capacity for irrigating a sizeable acreage are difficult to find. One should have at least one acre-foot (325,000 gallons) of storage for each acre irrigated. Thus for irrigating a 100-acre field, a reservoir with 10 acres of surface area and an average depth of 10 feet (or other dimensions to give equivalent volume) would be needed. This is a minimum storage capacity; some experts recommend at least twice this amount.

### Irrigation for Double Cropping

Proper irrigation can eliminate the most serious problem in double cropping — inadequate moisture to get the second crop off to a good start. During July and most of August, no part of the state has better than a 30 percent chance of getting 1 inch or more of rain per week. Farm operators who already own irrigation equipment ought to seriously consider double-crop farming, and those already double cropping ought to consider irrigating for best results. Soybean yields as high as 38 bushels per acre have been obtained with irrigation at Urbana when planted on July 6 following wheat harvest.

### Management Requirements

Irrigation will provide maximum benefit to the operator only when it is an integral part of a high-level management program. The best agronomic practices planned for high yield levels must be followed to get adequate return from irrigation. Good seed of proper genetic origin planted at the proper time and at sufficiently high plant population, accompanied by optimum fertilization, good weed control, and other cultural practices, will help assure maximum benefit from irrigation. There is little point in investing in an irrigation system unless high-level management practices are followed.

Some farmers who invest in irrigation soon become disappointed because they do not manage the irrigation properly. There is frequently a tendency to over-extend their systems to the extent that they cannot maintain adequate soil moisture when the crop requires it. For example, the system may be designed to apply 2 inches of water to 100 acres once a week. Two or more successive weeks may be encountered when soil moisture is limiting and potential evapotranspiration equals 2 inches per week. If the system is used on one 100-acre field one week and another field the next week, little benefit may be found in either field. This is especially true if moisture stress comes at pollination time. Inadequate pollination may result in barren stalks competing with grain-producing plants for moisture, nutrients, and light through the rest of the season. A high level of management of all practices, including irrigation, must result for optimum returns.

# 1976 FIELD CROPS WEED CONTROL GUIDE

This guide for using herbicides is based on research results at the University of Illinois Agricultural Experiment Station, other experiment stations, and the U.S. Department of Agriculture. Although not all herbicides commercially available are mentioned, an attempt has been made to include materials that were tested and showed promise for controlling weeds in Illinois. Consideration was given to the soils, crops, and weed problems of the state.

Rainfall, soil type, and method of application influence herbicide effectiveness. Under certain conditions some herbicides may damage crops to which they are applied. In some cases chemical residues in the soil may damage crops grown later.

When deciding whether to use a herbicide, consider both the risk involved in using the herbicide and the yield losses caused by weeds. If you do not have much of a weed problem and if cultivation and other good cultural practices are adequate for control, do not use herbicides. Much of the risk can be decreased by following these precautions:

- Use herbicides only on those crops for which they are specifically approved and recommended.
- Use no more than recommended amounts. Applying too much herbicide may damage crops, may be unsafe if a crop is to be used for food or feed, and is costly.
- Apply herbicides only at times specified on the label. Observe the recommended intervals between treatment and pasturing or harvesting of crops.
- Wear goggles, rubber gloves, and other protective clothing as suggested by the label. Some individuals are more sensitive than others to certain herbicides.
- Guard against possible injury to nearby susceptible plants, such as soybeans, grapes, and tomatoes. Droplets and vapors from 2,4-D, MCPA, 2,4,5-T, and dicamba sprays may drift for several hundred yards. If it is necessary to spray in the vicinity of such crops, the amine form of 2,4-D is safer to use than the volatile ester form, but even the amine spray may drift to susceptible crops. To reduce the chance of damage, calibrate and operate sprayers at low pressure with tips that deliver large droplets and high gallonage output. Spray only on a calm day or make sure air is not moving toward susceptible crop plants and ornamentals. Some farm liability insurance policies do not cover crop damage caused by the ester form of 2,4-D.
- Apply herbicides only when all animals and persons not directly involved in the application have been removed. Avoid unnecessary exposure.
- Return unused herbicides to a safe storage place promptly. Store them in original containers, away from unauthorized persons, particularly children.
- Properly dispose of empty herbicide containers. Rinse and puncture metal containers and haul them to a sanitary landfill. Haul paper containers to a sanitary landfill or burn them.
- Since manufacturers' formulations and labels are sometimes changed and government regulations modified, always refer to the most recent product label.

This guide is for your information. The University of Illinois and its agents assume no responsibility for results from using herbicides, whether or not they are used according to the suggestions, recommendations, or directions of the manufacturer or any governmental agency.

## Cultural and Mechanical Control

Plan your weed control program to fit your situation and desires. Be prepared to modify your plans as required during the season. Most weed control programs combine good cultural practices, mechanical weed control, and herbicide applications. If weeds are not serious, herbicide applications may not be needed.

Good cultural practices include good seedbed preparation, adequate fertility, optimum stands, optimum row width, and proper seeding date.

Prepare a uniform, weed-free seedbed to help discourage weed growth and encourage corn and soybean germination. Incorporation of preplant herbicides should be a part of normal seedbed preparation. Excessive preplant tillage may intensify soil crusting.

Planting in relatively warm soils helps soybeans and corn compete better with weeds. Good weed control during the first three to five weeks is extremely important for both corn and soybeans. If weed control is adequate during that period, corn and soybeans will usually compete quite well with most of the weeds that begin growth later. Optimum row width and plant populations also help discourage weed growth.

Narrow rows will shade the centers faster and help the crop compete better with the weeds. There is increased interest in drilling soybeans in narrow rows. Since herbicides alone may not always give adequate weed control, it is often preferable to keep rows wide enough to allow cultivation. However, some of the newer herbicides are improving the chances of adequate control without cultivation.

Early cultivations are most effective when weeds are small. Use the rotary hoe after weed seeds have germinated, but before most have emerged. Operate the rotary hoe at 8 to 12 miles per hour and weight it enough to stir the soil and kill the tiny weeds. Rotary hoeing also aids crop emergence if the soil is crusted.

Even though you have used a preemergence or preplant herbicide, if adequate control appears doubtful, use the rotary hoe while weeds are still small enough to be controlled.

Row cultivators should also be used while weeds are small. Throwing soil into the row can help smother small weeds, but be certain not to cover the crop. If a banded herbicide has given adequate weed control in the row, use shields to prevent soil movement into the row during the first cultivation. Cultivate shallow to prevent root pruning. Avoid excessive ridging as it may hinder harvesting and encourage erosion.

Preemergence or preplant herbicides may provide a convenient and economical means of early weed control by allowing delayed and faster cultivation. Herbicides can replace some cultivation, for unless the soil is crusted, little cultivation is needed where weeds are controlled.

## Chemical Weed Control

Plan your chemical weed control program to fit your soil, crops, weed problems, farming operations, and personal desires. Be prepared to modify your plans as required during the season. Herbicide performance depends on the weather and on wise selection and application of the herbicide. Your decisions on herbicide use should be based on the nature and seriousness of your weed problem.

Corn or soybeans may occasionally be injured by some of the herbicides cleared for use on them. Crop tolerance ratings for the various herbicides are given in the table on the last page. Usually the benefits from weed control are much greater than the adverse effects from herbicides. Corn or soybeans under stress from soil crusting, depth of planting, or adverse weather are more subject to herbicide injury. Plants injured by a herbicide are likely to be more subject to disease.

Apply the herbicide at the time specified on the label. Most preemergence herbicides should not be applied after the crop has emerged. Be sure to select and apply herbicides at the right rate to reduce the risk of crop injury. The application rate for some herbicides varies greatly with soil texture and organic matter.

You must also consider the kinds of weeds likely to be present. The herbicide selectivity table at the end of this guide lists the various herbicides and the relative control of various weeds. Most soybean herbicides do not give adequate control of some broadleaf weeds. If a serious broadleaf infestation is expected, it may be wise to plant corn since some of the corn herbicides are more effective on broadleaf weeds.

Crop planting intentions for the next season must also be considered. Where high rates of atrazine are used, such as to control quackgrass, you should not plant soybeans, small grains, alfalfa, or vegetables the following year. If you are considering planting wheat after soybeans be sure that the application of Treflan or similar herbicide is accurate, uniform, and sufficiently early to reduce the risk of wheat injury.

## Names of Some Herbicides

| Trade | Common (generic) |
|---|---|
| AAtram | atrazine plus propachlor |
| AAtrex, Atrazine | atrazine |
| Amex 820 | butralin |
| Amiben | chloramben |
| Amino triazole, Weedazol | amitrole |
| Amitrol-T, Cytrol | amitrole-T |
| Banvel | dicamba |
| Basagran | bentazon |
| Bladex | cyanazine |
| Butoxone, Butyrac | 2,4-DB |
| Cobex | dinitramine |
| Cycle | procyazine |
| Dowpon M, Basfapon | dalapon |
| Dyanap, Ancrack, Kleen-Krop | naptalam plus dinoseb |
| Eptam, Eradicane | EPTC |
| Evik | ametryne |
| Furloe Chloro IPC | chlorpropham |
| Kerb | pronamide |
| Lasso | alachlor |
| Lorox | linuron |
| Modown | bifenox |
| Outfox | cyprazine |
| Paraquat | paraquat |
| Premerge, Sinox PE | dinoseb |
| Princep | simazine |
| Prowl | penoxalin |
| Ramrod, Bexton | propachlor |
| Roundup | glyphosate |
| Sencor, Lexone | metribuzin |
| (several) | 2,4-D |
| Solo | naptalam plus chlorpropham |
| Surflan | oryzalin |
| Sutan, Sutan+ | butylate |
| Tenoran, Norex | chloroxuron |
| Tolban | profluralin |
| Treflan | trifluralin |
| Vernam | vernolate |

Some herbicides have different formulations and concentrations under the same trade name. No endorsement of any trade name is implied, nor is discrimination meant against similar products.

Where trade names are used in this publication, rates refer to the amount of commercial product. Where common or generic names are used, rates refer to the amount of active ingredient unless a formulation is stated. Unless otherwise stated, rates are given on a broadcast basis.

## Herbicide Combinations

Herbicides are often combined to control more weed species, reduce carryover, or reduce crop injury. Some combinations are sold as a "package mix" while others are tank-mixed. Tank mixing allows you to adjust the ratio to fit local weed and soil conditions. Tank mixes should be registered with the EPA, and mixing information should either be on the label of one of the components or appear as supplemental information. If you use a tank mix, you must follow restrictions on all products used in the combination.

Mixing problems sometimes occur when mixing emulsifiable concentrate (EC) formulations with wettable powder (WP) or water dispersible liquid (WDL) formulations. These problems can sometimes be prevented by using proper mixing procedures. Wettable powders should be added to the tank before EC's. Preemulsify EC's by mixing with equal volumes of water before adding them to the tank. Empty and clean spray tanks often to prevent an accumulation of material on the sides and in the bottom of the tank.

Some of the herbicide combinations that have been registered are listed below. The herbicide listed first is the one which carries label or supplemental instructions on mixing. The other herbicide's label may also carry mixing instructions.

**Corn**

AAtrex + Princep (PPI, Pre)[1]
Banvel + atrazine (Post)
Banvel + Lasso (Pre)
Banvel + 2,4-D (Post)
Bladex + atrazine (Pre)
Bladex + Paraquat (NT)
Bladex + Sutan+ (PPI)
Lasso + atrazine (PPI, Pre)
Lasso + Bladex (Pre)
Lorox + Lasso (Pre)
Paraquat + atrazine (NT)
Paraquat + atrazine + Lasso (NT)
Prowl + atrazine (Pre)
Prowl + Bladex (Pre)
Ramrod + atrazine (Pre)
Sutan + atrazine (PPI)

**Soybeans**

Amiben + Lorox (Pre)[1]
Dyanap + Lasso (Pre)
Furloe + Lasso (Pre)
Lasso + Lorox (Pre)
Lexone or Sencor + Lasso (Pre)
Lorox + Lasso (Pre)
Maloran + Lasso (Pre)
Paraquat + Lorox (NT)
Premerge + Amiben (Pre)
Premerge + Lasso (Pre)
Sencor or Lexone + Treflan (PPI)
Solo + Lasso (Pre)
Vernam + Treflan (PPI)

Policy on tank-mix and sequential applications is as follows.

1. All tank mixes and sequential applications registered with the EPA and stated on EPA-approved labels are legal.

2. Illinois law does not allow Illinois registration without federal registration.

3. Various tank mixes and sequential applications which have been tested and are common agricultural practices are considered consistent with the label (do not constitute a violation) if: they are not applied at a rate exceeding the label instructions for each herbicide, the label of one of the products does not explicitly prohibit such a mixture, and the use is consistent with the label.

The relaxed policy on the third group of combinations, those which are not registered with the EPA, does not indicate EPA approval for the mixtures. The user and applicator assume the risks involved with adverse effects such as crop injury, personal injury, mixing and application problems, and environmental effects.

Applying two herbicides at different stages of plant growth is a sequential, or overlay herbicide combination. The user can apply two treatments with the same herbicide (split application), or he can use two different ones. He can apply them at the preplant and preemergence stages, or at preemergence and postemergence. One herbicide may be broadcast while the other is banded or directed.

Labeling requirements for sequences are becoming strict. Some labels now suggest that other registered herbicides be sequenced, while others specify combinations. Some common corn herbicide sequences are:

Sutan+ (PPI) and 2,4-D (Post)
Ramrod (Pre) and 2,4-D (Post)
Lasso (Pre) and 2,4-D (Post)
Lasso (Pre) and atrazine (Post)

[1] PPI = preplant incorporated, Pre = preemergence, Post = postemergence, NT = no-till.

Some of the common soybean herbicide sequences are:

- Treflan (PPI) and Amiben (Pre)
- Treflan (PPI) and Dyanap (Pre-Post)
- Treflan (PPI) and Sencor or Lexone (Pre)
- Treflan (PPI) and Furloe (Pre)
- Lasso (Pre) and Tenoran (Post)
- Lasso (Pre) and Basagran (Post)

These listings show some of the possible sequential herbicide combinations that farmers are using, and do not imply label clearance.

## Herbicide Incorporation

Some herbicides must be incorporated to reduce surface loss caused by volatilization or photodecomposition. Those which are highly volatile need immediate incorporation. Incorporation of some herbicides may improve their performance by placing them in sufficient moisture to be absorbed by weeds, thus overcoming some of the dependence upon rainfall.

Depth and thoroughness of incorporation depend upon type of equipment, depth of operation, speed, soil texture, and soil moisture. It is important to obtain uniform distribution, both horizontal and vertical, to prevent areas of high and low concentrations which may result in injury, residue, or poor control.

Most annual weed seeds germinate in the top 1 or 2 inches of soil, where you want to place most of the herbicide. The tandem disk is the most common implement for incorporation. The disk tends to incorporate herbicides at about half the depth at which the disk is operated. Disking twice may result in more uniform distribution than disking once. The field cultivator has been used for incorporation, but streaking often results unless you use a drag-harrow behind the field cultivator. A disk with less than 22-inch blades used twice, or disking followed by field cultivating has usually given better herbicide distribution than using the field cultivator twice.

Speed and depth are important in obtaining satisfactory results with all equipment. Keep in mind that if the herbicide is incorporated too deep, dilution may reduce its effectiveness.

## Corn Herbicides

### Preplant Incorporation

Some herbicides may be applied prior to planting. Some require incorporation, while for others, it is optional. Preplant herbicides are usually broadcast and some may be applied with fluid fertilizer.

**AAtrex (atrazine)** can be applied within 2 weeks before planting corn. The reason for preplant incorporation of atrazine is to overcome some of the dependence upon rainfall. Incorporation should not be too deep.

AAtrex is very effective for control of many broadleaf weeds. Control of annual grass weeds is often satisfactory. However, AAtrex may not adequately control some annual grasses such as fall panicum, crabgrass, and giant foxtail. See further details under the discussion of preemergence applications for corn.

**Sutan+ (butylate)** needs immediate incorporation. Where possible, application and incorporation should be done in the same operation. Sutan+ is a new formulation of Sutan plus a crop safening agent which reduces the possibility of corn injury.

Sutan+ is cleared for field, sweet, and silage corn, but not for seed corn production. Sutan+ is primarily for control of annual grass seedlings, but will also suppress yellow nutsedge. Broadleaf weed control can be improved by a combination of Sutan+ with atrazine or with an appropriate postemergence application of 2,4-D.

Sutan+ (6.7E) is used alone at the rate of 3¾ to 4¾ pints per acre. It is also available as a 10-percent granule which does not contain the crop safener. The granular formulation also requires immediate incorporation.

**Sutan+ (butylate) plus atrazine** can be tank-mixed for preplant incorporation at rates of 1¼ to 2 pounds of AAtrex 80W, or 1 to 1½ quarts of AAtrex 4L plus 3¾ to 4¾ pints of Sutan+ (6.7E) per acre. The higher rate of AAtrex is suggested for the relatively dark soils.

**Princep (simazine) or Princep plus atrazine** may be broadcast in the spring, either before or during final seedbed preparation. Best results have usually been obtained when applied within 2 weeks prior to planting, although application within 4 weeks may be satisfactory when so stated on the label.

Princep used alone or in combination with atrazine usually gives better control of fall panicum and crabgrass than atrazine alone. Princep is less soluble than atrazine and may have more residual activity, so follow label precautions to minimize carryover. Princep and atrazine are used in a 1:1 combination, each at half its usual rate.

**Bladex (cyanazine) plus Sutan+ (butylate)** is registered for preplant incorporation in corn. However, incorporating Bladex may reduce its effectiveness.

**Eradicane** is a formulation of EPTC (Eptam) plus a crop-safening agent to reduce the possibility of corn injury. Although the safening agent does not appear to completely eliminate the risk of injury, the risk does appear to be considerably reduced. Eradicane is chemically related to Sutan+, but Eradicane usually gives better control of johnsongrass seedlings, wild cane, and nutsedge. Like Sutan, Eradicane should be incorporated immediately as a preplant broadcast treatment. Combinations of Eradicane with some triazine herbicides appear promising in research trials. Eradicane may be used on field and silage corn, but should not be used on corn grown for seed. Suggested rate is 4¾ to 7⅓ pints per acre within two weeks before planting. The higher rate is for heavy infestations of wild cane or nutsedge and suppression of rhizome johnsongrass.

**Lasso (alachlor) or Lasso plus atrazine** may be used preplant within seven days before planting corn. A surface application is usually preferred for control of annual grasses, but incorporation may improve nutsedge control. Consider using the higher rates of Lasso indicated on the label if Lasso is to be incorporated. See further details in the preemergence section.

### Preemergence Herbicides for Corn

**AAtrex (atrazine)** is available under several private brand names formulated by the same manufacturer. In addition, there may be some new trade names.

Atrazine controls both annual grasses and broadleaf weeds, but is especially effective on many annual broadleaf weeds. Fall panicum and crabgrass have sometimes become problems where atrazine has been used several years in succession. Atrazine usually controls weeds for most of the season, but may sometimes remain in the soil to damage certain crops the following season. If you use Atrazine in the spring, do not plant small grains, small-seeded legumes, or vegetables the next fall or spring. If you use AAtrex 80W at over 3.75 pounds per acre (or an equivalent rate of AAtrex 4L) or if you apply after June 10, plant only corn or sorghum the next year.

Soybeans planted the year following atrazine may be injured if you use more than recommended amounts, or overlap when broadcasting, or overdose when turning at the ends of fields. Carryover injury can be minimized by accurate mixing and early application, by use of the lowest rates consistent with good weed control, and by thorough tillage of the soil prior to planting subsequent crops.

Corn tolerance is very good with atrazine. You can use it on field corn, sweet corn, silage corn, popcorn, and seed production fields. It is available as an 80-percent wettable powder and a 4-pound-per-gallon liquid suspension. Rates vary with soil organic matter. Mix properly, provide adequate agitation, and follow other precautions on the label.

**Bladex (cyanazine)** is chemically related to atrazine. Corn tolerance is not as good as with atrazine and corn may sometimes be injured, especially under cool, wet stress conditions. However, soil persistence of Bladex is less than with atrazine. Bladex may control giant foxtail and fall panicum better than atrazine does, but control of some broadleaf weeds may not be as good (see the selectivity table on the last page).

Bladex is available as an 80-percent wettable powder, a 4-pound-per-gallon formulation, and a 15-percent granule. Use 1½ to 5 pounds of Bladex 80W, 1¼ to 4 quarts of Bladex 4-WDS, or 8 to 27 pounds of Bladex 15G per acre on a broadcast basis. Rates should be adjusted carefully for soil texture and organic matter to reduce the possibility of corn injury. Reduced rates of Bladex in approved combinations should also reduce the possibility of corn injury. Do not use on sands or soils low in organic matter.

Tank-mix combinations of Bladex with AAtrex or Lasso are registered for preemergence use. The Bladex: AAtrex ratios are 1:1 or 2:1 depending upon severity of grass infestation expected. The individual rates vary greatly with soil texture and organic matter, so refer to the Bladex label for exact rate information. The Bladex-Lasso combination specifies 2 quarts of Lasso with 1¼ to 2¾ pounds of Bladex, depending upon soil texture and organic matter. See either the Bladex or Lasso label for rates for specific soils.

**Cycle (procyazine)** is a new triazine herbicide that has performed like Bladex. Crop tolerance is not quite as good as with atrazine but persistence is less, permitting greater flexibility in cropping sequence. Registration and availability are expected for 1976. Combinations with herbicides such as Lasso and atrazine are likely to improve spectrum of control and persistence.

**Ramrod or Bexton (propachlor)** controls annual grasses and pigweed and is usually used on soils above 3 percent organic matter. Most other broadleaf weeds are not controlled. Some farmers band propachlor granules at planting time to control annual grass weeds and follow with an early postemergence herbicide to control broadleaf weeds.

Corn tolerance to propachlor is good. It is cleared on field corn, silage corn, sweet corn, and corn seed fields. It is irritating to the skin and eyes, so observe label precautions. Some individuals are more sensitive than others.

The broadcast rate is 6 to 9 pounds per acre of Ramrod 65W or 20 to 30 pounds per acre of Ramrod or Bexton 20G (granules). Bexton 20G is another new trade name for propachlor 20-percent granules. Use proportionately less for band application.

**Lasso (alachlor)** is similar to Ramrod in many respects, but it performs better than Ramrod on soils with less than 3 percent organic matter. Lasso may require more moisture initially, but weed control may last longer. Lasso is not as irritating to handle as Ramrod. However, some individuals may be sensitive, so observe label precautions.

Lasso controls annual grasses, pigweed, and lambsquarters. Other broadleaf weeds can be controlled with a postemergence herbicide treatment.

The broadcast rate is 1½ to 3 quarts of Lasso 4E or 16 to 26 pounds of Lasso II 15G. Adjust rate for soil texture and organic matter. Corn tolerance to Lasso is relatively good. However, slight injury has occasionally occurred to certain hybrids. Lasso may be used on field corn, sweet corn, and silage corn.

**Ramrod-atrazine** is a combination best adapted to soils over 3 percent organic matter. The mixture controls broadleaf weeds better than Ramrod alone and controls annual grasses better than AAtrex alone. However, velvetleaf may not be controlled. It reduces the AAtrex residue problem and often gives more consistent control on the darker soils with limited rainfall than AAtrex alone.

Ramrod-atrazine is available as a prepackaged mixture of wettable powder used at the rate of 6 to 8 pounds per acre. For tank mixing, use 4½ pounds of Ramrod 65W and 2 pounds of AAtrex 80W on soils with over 3 percent organic matter.

**AAtram 20G** is a granular combination containing 1 part atrazine and 2 parts propachlor. The rates are 15 pounds per acre broadcast on light soils and 22½ to 30 pounds per acre broadcast on moderately dark to dark soils. Use proportionately less for band applications.

**Lasso-atrazine** is preferable to Ramrod-atrazine on soils with less than 3-percent organic matter. Lasso-atrazine is less irritating to handle and controls fall panicum better than Ramrod-atrazine. Suggested rates for tank mixing are 1½ to 2 quarts of Lasso and 1¼ to 2 pounds of AAtrex 80W, depending upon soil organic matter. See the Lasso label for mixing instructions. There have been occasional problems in tank mixing AAtrex with Lasso EC, so check compatibility in small containers before mixing large batches. Do not graze or harvest for forage within 21 days after treatment.

**Banvel (dicamba) plus Lasso (alachlor)** is registered for preemergence use on corn. Adding Banvel to Lasso improves control of broadleaf weeds without creating risk of carryover injury to crops the following year. However, there is some risk of injury to corn from Banvel applied preemergence, especially if recommended rates are exceeded or applications are not accurate and uniform. The rate is 1 pint of Banvel plus 2½ quarts of Lasso per acre on soils with over 2½ percent organic matter.

**Prowl (penoxalin)** is registered for use on field corn and silage corn. It will be available as a 4-pound-per-gallon EC for use at rates of 1½ to 2 quarts alone, or 1 to 1½ quarts in combination with atrazine or Bladex. Rates should be adjusted for soil texture and organic matter. It controls annual grasses and some broadleaf weeds such as pigweed, lambsquarter, smartweed, and velvetleaf. Corn tolerance is limited, and Prowl should be applied only to the soil surface for corn since incorporation considerably increases the risk of injury.

**2,4-D ester** preemergence for corn controls broadleaf weeds and gives some control of grass weeds, but weed control is rather erratic. There is some chance of injury to the corn. Use only the ester form for preemergence, since the amine form is more subject to leaching.

**Amiben (chloramben) and Lorox (linuron)** have label clearance for preemergence use on corn, but risk of corn injury is considered too great to suggest their use alone for this purpose in Illinois. Reduced rates used in combinations reduce but do not eliminate the possibility of corn injury.

### Postemergence Herbicides for Corn

**AAtrex (atrazine)** can be applied early postemergence to corn up to 3 weeks after planting, but before grass weeds are more than 1½ inches high. Most annual broadleaf seedlings are more susceptible than grass weeds and most annual broadleaf weeds may be treated up to 4 inches high. Results on grasses larger than 1½ inches have been somewhat erratic.

The addition of nonphytotoxic oils, oil-surfactant mixes, or surfactants has generally increased the effectiveness of postemergence atrazine. The special nonphytotoxic spray oil is used at 1 to 2 gallons per acre. Formulations of 80 percent oil and 20 percent surfactant are used at the rate of 1 to 2 quarts per acre. Some surfactant-spreaders are also marketed for use with postemergence atrazine. These are usually added at 0.5 percent of the total spray volume or about 1 pint per acre. Results with the oils and oil-surfactant mixes have generally been better than with the surfactants.

Corn tolerance to atrazine-oil has been relatively good, but corn has sometimes been damaged. There have been a few cases of fairly severe injury where corn has been under stress from prolonged cold, wet weather or other factors.

Do not use over 2½ pounds of atrazine 80W or 2 quarts of AAtrex 4L per acre if you mix with oil. Do not add 2,4-D to the atrazine-oil treatment or severe injury may result. Mix the atrazine with water first and add the oil last. If atrazine is applied after June 10, do not plant any crop except corn or sorghum the next year because of risk of herbicide carryover. Refer to the label for other precautions.

**Bladex (cyanazine)** is cleared for postemergence use through the four-leaf stage of corn growth, but before annual grasses exceed 1½ inches in height. The rate is 1½ to 2½ pounds of Bladex 80W in 15 to 30 gallons of spray per acre. Injury to corn may occur under cold, adverse growing conditions. The injury may be only temporary yellowing or may be more severe under unfavorable conditions. Corn should not be treated after the four-leaf stage. Certain agricultural surfactants or vegetable oils may be added to Bladex, but do not use petroleum crop oils for postemergence application.

**Outfox** (**cyprazine**) is a postemergence corn herbicide formulated as a 1-pound-per-gallon suspension in oil. The suggested rate is 3 quarts per acre when grasses are less than 2 inches high. Do not apply after corn is 10 inches tall. Corn injury has occurred, but has not generally been severe. At the rates used, carryover should not be a serious problem.

**2,4-D** provides one of the most economical and effective treatments for controlling many broadleaf weeds in corn. Use drop nozzles if corn is over 8 inches high to help keep 2,4-D out of the corn whorl and decrease the possibility of injury. If you direct the nozzles toward the row, adjust the spray concentration so that excessive amounts are not applied to the corn.

If you wish to control late-germinating weeds, you can use high-clearance equipment, but do not apply 2,4-D to corn from tasseling to dough stage.

Some corn injury may result from 2,4-D application. Corn is often brittle for 7 to 10 days after application and thus is susceptible to stalk breakage from high winds or cultivation. Other symptoms of 2,4-D injury are stalk bending or lodging, abnormal brace roots, and failure of leaves to unroll, sometimes called "onion leafing."

Spraying when corn is under stress (cool, wet weather) or when corn is growing very rapidly may increase the possibility of corn injury. Some corn inbreds are more susceptible than others. Corn hybrids vary in their sensitivity to 2,4-D, depending upon their genetic makeup.

Apply no more than the recommended rate to help avoid corn injury. The suggested broadcast rates of acid equivalent per acre are ⅙ to ¼ pound of ester formulations or ½ pound of amine. This would be ⅓ to ½ pint of ester, or 1 pint of amine for formulations with 4 pounds of 2,4-D acid equivalent per gallon.

The ester forms of 2,4-D can vaporize and injure susceptible plants nearby. This vapor movement is more likely with high-volatile than with low-volatile esters. Amine formulations are relatively nonvolatile and are less likely to injure nearby susceptible plants. However, when spraying either ester or amine forms, spray particles can drift and cause injury.

Dacamine and Emulsamine are oil-soluble amines of 2,4-D. Since they are formulated in oil like the esters they are said to have the effectiveness of the esters, but to retain the low-volatile safety features of the amines.

The active ingredient in the various formulations of 2,4-D is still 2,4-D and when you adjust rates appropriately to provide equivalent weed control and crop safety the various formulations are usually similar in their effectiveness.

**Banvel** (**dicamba**) is similar to 2,4-D in some respects, but controls smartweed better than 2,4-D. However, *Banvel has presented a much more serious problem of injury to soybeans than 2,4-D.* Thus, Banvel should be applied before soybeans in the area are 10 inches high. Soybean yields may not be reduced where slight injury occurs early. However, yields can be reduced when severe injury occurs when soybeans are blooming. Banvel can also affect other susceptible plants such as vegetables and ornamentals. Use extreme caution to avoid injury to desirable plants from either contaminated sprayers or drift of Banvel from treated areas. Spray thickeners and foam additives have reduced, but not eliminated, problems with movement of Banvel.

Banvel may be applied until corn is 3 feet high or up to 15 days before tassel. If corn is over 10 inches high, drop nozzles give better weed coverage and reduce drift. If you direct the nozzles toward the row, adjust the spray concentration so that excessive amounts are not applied to the corn. Corn tolerance is relatively good with Banvel, however corn injury can occur. Broadcast rates are ¼ to ½ pint per acre. Use the higher rate for taller weeds.

Do not use Banvel on sweet corn or popcorn. Do not graze or harvest corn for dairy feed before the ensilage (milk) stage.

A mixture of ¼ pint of Banvel plus ½ pint of 2,4-D amine per acre is more economical than a full rate of Banvel and presents less risk of corn injury than 2,4-D alone. Use drop nozzles on corn over 8 inches high when using the Banvel-2,4-D mixture.

### Directed Postemergence Herbicides for Corn

Directed sprays are sometimes needed for emergency situations, especially when grass weeds become too tall for control with cultivation. However, weeds are often too large for directed sprays to be very practical when help is sought. Place primary emphasis on early control measures such as use of preemergence herbicides, rotary hoeing, and timely cultivation.

Directed sprays cannot be used on small corn and a height difference between corn and weeds is usually needed to keep the spray off of the corn. Corn leaves that are contacted can be killed and injury may affect yields.

**Lorox** (**linuron**) may be applied as a directed spray after corn is at least 15 inches high (to the top of the free standing plant), but before weeds are 8 inches tall (preferably not over 5 inches). This height difference occurs in few fields and lasts only a few days. Lorox can control both grass and broadleaf weeds.

Broadcast 1¼ to 3 pounds of Lorox 50W, with the lower rates used on small weeds, lighter soil types, and soils low in organic matter. Add Surfactant WK at the rate of 1 pint per 25 gallons of spray mixture. Cover the weeds with the spray, but keep it off the corn as much as possible. Refer to the label for other precautions. *Consider this an emergency treatment.*

**Evik 80W (ametryne)** is cleared for directed use when corn is over 12 inches tall and weeds are less than 4 inches tall. The rate is 2 to 2½ pounds Evik 80W per acre (broadcast basis) plus 2 quarts of surfactant per 100 gallons of spray mixture. Extreme care is necessary to keep the spray from contacting the leaves. Injury to corn is possible, so *use only as an emergency treatment.* To avoid possible yield reduction, Evik should not be applied within 3 weeks of tasseling.

## No-Till Corn

No-till (zero-till) corn puts chemical weed control to a real test. You must control both vegetation existing at planting and weed seedlings which begin growing after planting. Existing vegetation may be a perennial grass sod, a legume or legume-grass sod, an annual cover crop, or weeds which begin growing before planting.

Paraquat (1 to 2 pints per acre) plus AAtrex 80W (2½ to 3¾ pounds per acre) are the most common herbicides used in no-till corn. The Paraquat has a contact action, while the AAtrex provides both pre- and postemergence control. Use 40 to 60 gallons of spray per acre and add a non-ionic surfactant at ½ pint per 100 gallons of diluted spray.

A pretreatment with 2,4-D or Banvel can improve control of alfalfa considerably. Fall panicum and crabgrass may not be controlled by the AAtrex. A mixture of AAtrex-Lasso or AAtrex-Princep will usually control these grasses. The AAtrex-Lasso mixture is 1½ to 2 quarts of Lasso plus 1½ to 2 pounds of AAtrex 80W per acre. The AAtrex-Princep mixture is 1¼ to 2 pounds of AAtrex 80W plus 1¼ to 2 pounds of Princep 80W per acre. Bladex + Paraquat is also registered for no-till corn.

## Soybean Herbicides

You must consider the kinds of weeds likely to be present when you select preplant and preemergence herbicides for soybeans. The herbicide selectivity table on the last page lists the various herbicides and the relative control of various weeds.

Soybeans may occasionally be injured by the herbicides registered for use. Fortunately, soybeans often can outgrow modest amounts of early injury without reducing yields. Use high-quality seed of disease-resistant varieties and do not plant too deep. Soybeans injured by a herbicide are likely to be more subject to disease.

### Preplant Herbicides for Soybeans

Incorporation can be performed with several implements listed on the label, but the most common in Illinois is the tandem disk. Disking twice in different directions may improve herbicide distribution. The second incorporation, whether with disk or field cultivator, should not be deeper than the first. Streaking has often resulted from using the field cultivator unless soil is in good tilth and the equipment is operated correctly.

See the earlier section on herbicide incorporation and the label for further information on incorporation of preplant herbicides.

**Treflan (trifluralin)** alone can be applied anytime in the spring before planting, but should be incorporated into the soil within 8 hours of application. Immediate incorporation is preferred, especially if soil is moist or winds are over 10 miles per hour.

Treflan controls annual grasses including wild cane and johnsongrass seedlings. It also controls pigweed and lambsquarters, but doesn't control most other broadleaf weeds. Certain preemergence herbicides are cleared for use after preplant application of Treflan to control some broadleaf weeds. A tank mix of Treflan plus Sencor or Lexone is also cleared to improve broadleaf control, but do not apply before 2 weeks from planting.

Soybeans are sometimes injured by Treflan. Injury symptoms are stunted plants with swollen hypocotyls and lateral root inhibition. Injury from Treflan on a statewide basis is not a serious problem, but may be significant in fields under cool, wet conditions.

There have been a few cases of injury to corn or small grains grown after Treflan was applied to soybeans. In many of these fields the soybean stubble was not plowed. Excessive applications were also the cause in some fields. Use no more than recommended rates. Apply carefully to avoid overlapping application.

The rate of Treflan is 1 to 2 pints per acre. Use 2 pints on silty clay loam or clay loam soils with over 4 percent organic matter. Use 1 to 1½ pints on soils coarser in texture and lower in organic matter. Treflan is also available as a 5-percent granule.

**Sencor or Lexone (metribuzin) plus Treflan (trifluralin)** is cleared either as a tank mix or serial combination. Rate of Sencor or Lexone is ½ to 1 pound plus the usual rate of Treflan. The tank-mix preplant combination should be applied within 2 weeks of planting. Incorporation of the preplant combination should be shallow but thorough.

**Cobex (dinitramine)** controls the same weeds as Treflan, but soybean tolerance is not as good. Soybeans under stress from disease, deep planting, or cold wet weather may be more susceptible to injury. The suggested rates are ⅔ to 1⅓ quarts of Cobex per acre, depending upon soil texture and organic matter. Cobex needs thorough incorporation into the soil within 24 hours after application. Shallow incorporation may reduce risk of soybean injury, but may also make weed control more variable.

**Tolban (profluralin)** is a dinitroaniline herbicide similar to Treflan. Both control the same weeds, and soybeans tolerate them about the same. Soil persistence is also similar. Rates are 1 to 2 pints of Tolban 4E, depending upon soil texture and organic matter. At these rates, weed control may be erratic on soils with over 4 or 5 percent organic matter. It should be incorporated within 4 hours after application.

**Amex 820 (butralin)** is also a dinitroaniline herbicide similar to Treflan and controls the same weeds. It needs thorough incorporation into the soil by double-disking to a depth of 2 to 4 inches as soon after application as possible. Use 2 to 2½ quarts on silty clay loam or clay loam soils, and 1½ to 2 quarts on soils coarser in texture and lower in organic matter.

**Vernam (vernolate)** controls annual grasses and pigweed. Control of morningglory and velvetleaf is sometimes fair. Vernam may also suppress nutsedge. *Some soybean injury occurs* in the form of delayed emergence, stunting, and leaf crinkling. The injury is usually temporary and is usually not reflected in final yields. Vernam can be applied up to 10 days prior to planting. Incorporate immediately to prevent surface loss. The broadcast rate is 2⅓ to 3½ pints of Vernam 7E or 20 to 30 pounds of Vernam 10G per acre.

**Vernam plus Treflan** is cleared as a tank-mix combination. The reduced rate of Vernam used in the combination may decrease the risk of soybean injury, but may also decrease control of velvetleaf and yellow nutsedge. The rate is 1 pint of Treflan 4E plus 2⅓ pints of Vernam 7E on most soils.

**Lasso (alachlor)** is sometimes applied preplant for nutsedge suppression at rates of 2½ to 3½ quarts per acre. Apply preplant within 7 days of planting. Preemergence application is usually preferred for control of annual grasses (see preemergence section).

#### Preemergence Herbicides for Soybeans

**Amiben (chloramben)** controls many annual grass and broadleaf weeds in soybeans. It does not control morningglory. Control of cocklebur and jimsonweed is erratic. Amiben occasionally injures soybeans, but damage is usually not severe. Injury appears as malformed roots and stunted plants.

The recommended broadcast rate is 1½ gallons of Amiben liquid (2S) or 30 pounds of Amiben 10G per acre. The 1-gallon or 20-pound rate sometimes used on lighter soils provides significantly less weed control, but may be adequate under some situations.

*If rainfall doesn't occur within three to five days, you should rotary hoe or harrow to control the small weeds.*

**Lorox (linuron)** is best adapted to the silt loam soils of southern Illinois which contain less than 2 to 3 percent organic matter. On these soils, a rate of 1 to 1½ pounds per acre of Lorox 50W frequently controls most weeds. *The margin of selectivity between dependable weed control and crop damage is rather narrow.* Careful rate selection and accurate and uniform application will reduce the possibility of crop injury. Stress conditions caused by insects, seedling diseases, low seedling vigor, deep or shallow planting, or climatic conditions may increase the likelihood of soybean injury.

The rate of Lorox should be adjusted for soil texture and organic matter (see Lorox label). Lorox is generally not recommended alone on soils with over 4 percent organic matter.

Lorox controls a broad spectrum of weeds, but grass weeds are not usually controlled as well as broadleaf weeds. Morningglory is not controlled and control of cocklebur is variable. Lorox is often used in a mixture with Lasso or as an "overlay" treatment after Treflan to control broadleaf weeds.

**Lasso (alachlor)** controls annual grasses plus pigweed and lambsquarters. Lasso will also suppress nutsedge when incorporated preplant at higher rates (see preplant section). Preemergence application is usually preferred for annual grass control. The broadcast rate is 2 to 3½ quarts of Lasso 4E or 16 to 26 pounds of Lasso II 15G per acre. Soybean seedlings often show a crinkling or drawstring effect on the first to second trifoliolate leaves. However these symptoms can be caused by other stresses and would not reduce soybean yield or permanently injure plants.

**Lasso plus Lorox** is a tank-mix combination which gives better broadleaf control than Lasso alone and better grass control than Lorox alone. The reduced rate of Lorox in the combination reduces but does not eliminate the risk of soybean injury.

The broadcast rate is 1½ to 3 quarts of Lasso 4E plus 1 to 3 pounds of Lorox 50W. Rates must be adjusted for soil texture and organic matter. This combination is best adapted to silt loam soils with less than 3 percent organic matter. On these soils such as occur in southern Illinois, the common rate is 1½ to 2 quarts of Lasso 4E plus 1 pound of Lorox 50W. Select rate carefully to reduce the risk of injury but to maintain control of jimsonweed and cocklebur.

**Sencor or Lexone (metribuzin)** has given good control of most annual broadleaf weeds except morningglory. Control of cocklebur, giant ragweed, and jimsonweed may be marginal, and annual grass control is marginal to erratic at rates needed to minimize crop injury.

*The margin of selectivity between dependable weed control and crop damage is rather narrow.* Some soybean varieties may be more susceptible than others. Stress conditions caused by cold, wet weather, soybean seedling diseases, depth of planting, or injury from other herbicides may increase the possibility of soybean injury from Sencor or Lexone. Planting too deep may result in slow seedling emergence, while planting too shallow may leave the germinating soybean seed in the most concentrated herbicide zone.

Rates vary with soil texture and organic matter. Adjust rates accurately for soil conditions and *do not apply to sandy soils.* The suggested rate alone is ¾ to 1½ pound of Sencor 50W, or ¾ to 1 pound of Lexone 50W per acre. Grass control with the use of Sencor or Lexone is erratic at rates used to minimize soybean injury. Sencor or Lexone are cleared as a tank-mix with Treflan (see preplant section), or as a preemergence treatment following preplant incorporation of Treflan.

**Sencor or Lexone (metribuzin) plus Lasso (alachlor)** is cleared as a tank-mix preemergence herbicide combination to improve grass control and decrease risk of soybean injury. The rate of Sencor or Lexone must be adjusted carefully to soil texture and organic matter. The rates for this combination vary somewhat on the three different labels but are ¾ to 1 pound of Sencor or Lexone 50W, plus 1½ to 2½ quarts of Lasso 4E on most Illinois soils (see labels for exact information). Accurate, uniform application is essential to minimize risk of soybean injury.

**Surflan (oryzalin)** is a dinitroaniline herbicide similar to Treflan. It is for preemergence (surface) application for soybeans being grown on soils with less than 3 percent organic matter. Surflan will control annual grasses, pigweed, and lambsquarters if adequate rain occurs. If ½ inch of rain does not occur within seven days after application, you should rotary hoe to control emerging weeds. Rates are 1 to 2⅓ pounds of Surflan 75W per acre depending on soil texture. Tank-mix combinations with Lorox, Sencor, or Dyanap are cleared in 1976 to improve broadleaf weed control. Surflan shows promise for use in no-till or double-crop soybeans where johnsongrass or wild cane seedlings are a slight, but not severe problem. Combinations with Paraquat are not yet cleared.

**Furloe Chloro-IPC (chlorpropham)** has been used in combination with other herbicides to control smartweed. A broadcast rate of 2 to 3 quarts of Furloe is suggested. A tank-mix with Lasso is cleared for preemergence use. Furloe is also cleared for preemergence use after preplant application of Treflan.

**Solo (naptalam plus chlorpropham)** has been rather erratic in weed control. Broadleaf weeds are usually controlled better than grasses. A tank-mix combination of Solo and Lasso is cleared to improve grass control.

Soybeans are sometimes injured by Solo, especially when heavy rains follow soon after application. This injury appears as stunted, distorted plants and as stand reduction. The broadcast rate for Solo is 1 to 2 gallons of Solo liquid or 25 to 40 pounds of granules.

**Modown (bifenox)** is a new preemergence herbicide for soybeans. It controls some problem broadleaf weeds such as smartweed and jimsonweed but does not provide good control of problem weeds such as cocklebur, morningglory, and annual grasses. It is cleared as a sequential treatment over Treflan and will soon be cleared as a tank-mix with Lasso to improve annual grass control. Soybeans are likely to show stunting and crinkling from Modown. This injury usually lasts only 1 to 2 weeks and may not cause yield reductions unless a secondary stress occurs.

Modown will be available as an 80 percent wettable powder formulation. The rate alone and over Treflan is 2½ pounds of Modown 80W per acre. The tank mix with Lasso will be 2 pounds of Modown 80W plus 2 to 2½ quarts of Lasso per acre.

**Dyanap (dinoseb plus naptalam)** can be applied to soybeans from planting until the unifoliate leaves of seedlings unfold, exposing the growing point. Preemergence application has usually resulted in more variable control, but the time available for the early postemergence application is only 2 to 4 days. Rain delay could prevent timely and legal application. Broadleaf weed control is better than grass control. A tank mix of Dyanap plus Lasso is cleared for both the preemergence and early postemergence treatment to improve grass control. However, late application of Lasso may result in variable grass control.

Ancrack and Kleen-Krop are other trade names for the formulated mixture of dinoseb plus naptalam. However, they are not cleared for combination with Lasso or late preemergence application. *Neither Dyanap, Ancrack, nor Kleen-Krop is registered in Illinois for late postemergence (salvage) use in soybeans.*

**Premerge Dinitro Weed Killer (dinoseb)** is cleared for tank mixing with Lasso or Amiben for preemergence use until soybeans begin to emerge (cracking stage). See below for further information on dinoseb.

#### Postemergence Herbicides for Soybeans

The postemergence use of herbicides for soybeans has never been very popular in Illinois. Postemergence herbicides for soybeans do not control annual grasses, and their use for broadleaf weeds is too often as emergency or "rescue" treatments. Soybeans are injured by some of the herbicides available for postemergence use. If there is a height difference between soybeans and weeds, directed sprays will decrease the amount of soybean injury by aiming the sprays away from the soybeans and toward the weeds.

**Dinoseb** water-soluble salts are sold under several trade names, including Premerge Dinitro Weed Killer and Sinox PE. One clearance is for early postemergence use when soybeans are still in the cotyledon stage. Do not apply if first leaves have opened to expose the terminal bud. Do not apply if soil surface is moist.

Dinoseb is primarily a contact herbicide which controls broadleaf weeds. It does not control annual grasses very well and gives very little residual control of seedlings germinating after application. It is cleared for tank-mixing with Lasso for early postemergence use to improve grass control. Dinoseb is also cleared for directed postemergence treatment when soybeans are 5 to 6 inches high and until they begin to bloom.

The postemergence rates for dinoseb vary with air temperature, formulation, and type of application (see label). Do not apply if air temperature is over 90° F. *Caution: Dinoseb is quite toxic to man and animals.* Exercise extreme caution when using this material.

Dinoseb is also cleared as a salvage treatment over the tops of soybeans after true leaves have unfolded and until soybeans begin to bloom. This treatment is for use where weed infestations such as cocklebur or morningglory are so serious that treatment is the only alternative to replanting. Crop injury is likely and the grower assumes the risk. The rate is 1 to 2 pints per acre. Do not use surfactant. Plan on additional postemergence treatments for satisfactory weed control.

**Tenoran, Norex (chloroxuron)** can be applied from the time trifoliolate soybean leaves form and until broadleaf weeds reach 1 to 2 inches tall. It controls most annual broadleaf weeds in soybeans, but control of velvetleaf is erratic. Chloroxuron does not usually control annual grasses. Weed control with chloroxuron has been somewhat erratic and soybeans usually show some injury. However, this early season injury has not usually reduced soybean yields.

The broadcast rate is 2 to 3 pounds per acre of Tenoran 50W or Norex 50W plus 1 pint of an approved compatible surfactant per 25 gallons of spray. Use proportionately less for directed or semi-directed sprays. A nonphytotoxic oil can be used at 1 gallon per acre instead of the surfactant with the directed or semi-directed sprays.

**Basagran (bentazon)** is a new postemergence herbicide for soybeans. Basagran controls many problem broadleaf weeds such as cocklebur, jimsonweed, and velvetleaf. It is weak on pigweed, lambsquarters, and annual morningglory. It may provide some control of yellow nutsedge, but will not control annual grasses. If annual grasses are a problem, it will be necessary to use a preemergence or preplant herbicide prior to using Basagran.

Basagran is a 4-pound-per-gallon formulation. The suggested rate is ¾ to 1½ quarts per acre, depending on weed size and species. Application when weeds are small and actively growing will give best results. However, too early an application may allow late-emerging weeds to escape. Use 15 to 40 gallons of water to get complete weed coverage. Use of a suitable surfactant at 0.25 to 0.5 percent by volume may increase the activity at lower application rates and give better coverage.

**2,4-DB** amine formulations are sold under the tradenames of Butoxone SB and Butyrac for postemergence control of cocklebur in soybeans. Besides cocklebur, 2,4-DB may also give some control of morningglory and giant ragweed. It can be applied broadcast over the top from 10 days before soybeans begin to bloom until mid-bloom, but expect some soybean injury. Injury symptoms include leaf wilting and stem curvature. Cracking of stems and proliferated growth may occur at the base of the soybeans. Lodging may be increased and if excessive rates are used or if unfavorable conditions exist, yields may be reduced. Consider 2,4-DB for emergency control of cocklebur when benefit from weed control will overshadow risk of soybean injury.

Directed sprays may reduce severity of injury. 2,4-DB can be directed when soybeans are at least 8 inches high and cockleburs are less than 3 inches high, if this height difference occurs. Do not spray on more than the lower third of the soybean plant. Do not apply if soybeans show symptoms of Phytophthora root rot disease or if soybeans are under drouth stress.

**Butyrac 200 plus Lorox (tank-mix), and Paraquat alone** are also cleared for directed postemergence treatment in soybeans to control certain problem weeds. However, their usage has not been great in Illinois. Soybeans must be at least 8 inches tall and weeds not over 2 inches. Nozzles must be adjusted accurately to spray only the lower one-third of the soybean plant or serious soybean injury can occur. Read the labels for the correct rate and precautions.

### Paraquat Harvest Aid

Paraquat is registered for drying weeds in soybeans. It may be applied when beans are fully developed, and when at least half of the leaves have dropped and the rest are turning yellow. If applied before beans are fully developed, yield reductions can result. Do not apply unless beans are ready to withstand frost.

The recommended rate is ½ to 1 pint per acre on a broadcast basis. Use the higher rate on cocklebur. Use the suggested rate in 20 to 40 gallons of spray per acre for ground application, or in 2 to 5 gallons per acre for aerial application. Add 1 quart of a non-ionic surfactant (X-77 or similar) per 100 gallons of spray. Do not pasture livestock within fifteen days of treatment, and remove livestock from treated fields at least thirty days before slaughter.

## Double-Crop Soybeans

In southern Illinois, there is often a chance to grow soybeans after harvesting wheat. The no-till concept has greatly improved the probability of success by conserving moisture and time. This now makes the planting of soybeans in wheat stubble well worth considering. The method may not be successful in occasional dry years, and yields may sometimes be disappointing. Planting soybeans after wheat can often be quite successful though, and can increase income with little additional investment.

If no weeds are present or if they are very small, you may not need a contact herbicide such as Paraquat. Lorox, Sencor, or Lexone have some postemergence effect, especially if a surfactant is added. Use the highest rate recommended for the soil type. If you anticipate a serious annual grass problem, you should add 1½ to 2 quarts of Lasso, or 1½ to 2⅓ pounds of Surflan.

If weeds are over 1 inch tall at spraying, the addition of 1 to 2 pints of Paraquat will improve the control of existing weeds. If weeds are over 6 inches, use the higher volumes of water suggested on the Paraquat label. Use a non-ionic surfactant such as Ortho X-77 at 8 ounces per 100 gallons of diluted spray. Fall panicum and smartweed control has been erratic. For more information see "Double Cropping in Illinois" (Circular 1106).

## Sorghum Herbicides

Sorghum acreage is not large in Illinois. However, it is usually grown in southern Illinois and in bottomlands where weed problems are severe. Because of low acreages, most dealers do not stock specialty sorghum herbicides, so herbicides cleared for both corn and sorghum are often used.

**AAtrex (atrazine)** may be used for weed control in sorghum or sorghum-sudan hybrids (grain and forage types). Application may be made preplant, preemergence, or postemergence. Sorghum is most tolerant to postemergence application. Injury may occur from preplant or preemergence applications when sorghum is under stress from unusual soil or weather conditions, or when rates are too high. Rate of application for preplant and preemergence is 2 to 3 pounds of atrazine 80W per acre. The postemergence rate is 2½ to 3¾ pounds. Follow rates and precautions on the label carefully. Rotational crop recommendations and weed control are the same as for atrazine used in corn. Failure to control fall panicum has been one of the big problems.

**Ramrod (propachlor)** may be used alone or in combination with atrazine for sorghum. Ramrod will improve grass control, but rates must not be skimpy, especially on soils relatively low in organic matter. Bexton 20G is another trade name for propachlor granules.

**Igran (terbutryne)** is a short-residual, triazine preemergence herbicide for sorghum. It may be applied alone or in tank-mix combination with AAtrex 80W or Milogard 80W. The combinations are especially recommended on sandy soils. The rates of Igran 80W alone are 2 to 3 pounds per acre. Do not wait more than 2 days after planting to apply, and do not apply over emerged sorghum. Heed all label precautions. Winter wheat can follow 4 months after sorghum has been treated with Igran alone. Combinations of Igran with AAtrex or Milogard have the same rotational restrictions as for either AAtrex or Milogard alone.

**Milogard (propazine)** has better sorghum tolerance than either atrazine or Igran, but grass control may not be as good. Only corn or sorghum may be planted in rotation within 12 months after treatment. Other crops in rotation have an 18-month restriction following treatment of sorghum with Milogard. Rates are 2½ to 3 pounds of Milogard 80W per acre.

**Bladex (cyanazine)** is cleared for preemergence sorghum use only in tank-mix combinations with Milogard or Ramrod. Sorghum tolerance is inadequate for using Bladex alone. The Bladex label has rates and precautions.

**2,4-D** may be applied postemergence for broadleaf control in 4- to 12-inch tall sorghum. Use drop nozzles if sorghum is over 8 inches tall. Rates are similar to those for corn.

**Banvel (dicamba)** is cleared for postemergence use in sorghum to control broadleaf weeds. Sorghum tolerance is fair. However, since sorghum is ready for postemergence treatment when soybeans are beginning to bloom, potential drift damage to soybeans is great. Apply ½ pint within 10 to 25 days after sorghum emergence. Earlier or later treatment can cause serious sorghum injury.

## Small Grain Herbicides

Small grains seeded in the fall or early spring often compete very well with most weeds if the stand is good and fertilized adequately. Herbicide suggestions for small grains underseeded with a legume differ from those for small grains growing alone. If wild garlic is a problem, do not plan to underseed with a legume, and see the special weed section for herbicide suggestions.

**2,4-D** is used to control certain broadleaf weeds. Winter wheat is more tolerant to 2,4-D than oats, but do not spray wheat in the fall. Spray small grains in the spring after the grain (wheat or oats) has fully tillered, but before it begins rapid stem elongation. Spraying in the boot stage may injure crops and reduce yield. If the small grain is underseeded with a legume, use only the amine formulation of 2,4-D. Follow rate suggestions accurately to minimize possible injury. Ester formulations may be used where there are no legume underseedings and are suggested for wild garlic control (see special weed section).

**MCPA** is less likely to damage oats and legume underseedings than 2,4-D, but is more expensive and will not control as many weeds. For small grains underseeded with a legume, use ¼ pound per acre (active ingredient) when the small grain is between the tiller and boot stages and when legumes are 2 to 3 inches tall.

**2,4-DB** is no longer cleared for use on small grains and should not be applied to legume underseedings until the grain crop is harvested.

**Banvel (dicamba)** should not be used on small grains that have a legume underseeding. It will control wild buckwheat and smartweed better than 2,4-D, but is poorer in controlling mustards. It may be used alone or in combination with 2,4-D. Banvel K is a formulated mixture of dicamba and 2,4-D amine. Banvel should be applied after winter wheat has fully tillered and before it begins to joint (nodes begin to form in the stem). Do not apply later or lodging and yield reductions can occur. The rate is for ¼ pint of Banvel alone or with 4 to 6 ounces of 2,4-D (active ingredient) per acre.

Stubble fields of small grains that have not been underseeded with a legume or double-cropped are often neglected and become infested with weeds after harvest. These weeds may not present an immediate economic problem to the grower, but they do supply weed seeds to affect the future crops and can cause hay fever problems from weeds such as ragweed. Tillage can be used to control weeds in stubble fields, but this requires time, manpower, and fuel, and may subject the land to erosion. Mowing may control some weeds, but many species grow back rapidly.

Chemical control can often be quite effective and economical, while leaving some residue for soil protection. In small grain stubble not underseeded with legumes, most broadleaf weeds can be controlled with 2,4-D, and dalapon can control many grasses. Rates may be varied depending on the kind and size of weeds present. Usually ¼ to 1 pound of 2,4-D and 3 to 7 pounds of dalapon are adequate. Weeds should be treated when actively growing. Follow label directions carefully.

## Forage Crop Herbicides

Weed control in alfalfa and clovers differs according to crop species and type of seeding — crop alone (pure seeding) or in combination with a grass species. Be sure to consult the label for proper use. Alfalfa and most clovers can be established without a companion crop and where there is not a forage grass-legume mixture by using Eptam or Balan.

**Eptam (EPTC) 7E** may be applied at a rate of 3½ to 4½ pints per acre and incorporated just before planting. It is most effective on grasses. Use the higher rate where broadleaf weeds and nutsedge are problems.

**Balan (benefin)**, used preplant, is incorporated at a rate of 3 to 4 quarts per acre and applied up to 10 weeks before planting. The rate varies with soil type. It will control many annual grasses and some broadleaf weeds.

**Butoxone or Butyrac (2,4-DB)** can be used postemergence to control broadleaf weeds in alfalfa and most clovers after the companion crop is removed, or in legume only or legume-grass seedings established without a companion crop. Rates vary with the kind and size of weeds present, and are 1 to 2 quarts per acre of ester formulations or 1 to 3 quarts of the amine formulation. Ester formulations may be used on alfalfa and birdsfoot trefoil. Do not use the ester formulations on most clovers. Do not graze livestock on or cut hay from treated fields within 30 days after treatment.

**Princep (simazine)** can be applied to pure alfalfa stands established over 12 months. Apply after the last cutting in the fall but before the ground is permanently frozen. Do not apply to alfalfa covered with snow. Princep applied to alfalfa-forage grass mixtures can kill the forage grass. Princep will control many grasses and broadleaf weeds but not already established perennial or biennial weeds. Rates are 1 to 1½ pounds per acre depending on soil type.

**Kerb (pronamide)** can be applied to either newly seeded alfalfa or established alfalfa during the fall or winter while alfalfa is dormant. Fall application is considered best for most weeds. It will control most annual grass and broadleaf weeds and help suppress quackgrass. Do not apply to mixed stands of alfalfa and forage grasses. Rates vary with weeds and soils. Do not harvest within 90 days after applying 3 to 4 pounds per acre or within 60 days after applying less than 3 pounds per acre.

**Furloe Chloro IPC (chlorpropham)** may be applied to active, semi-dormant, or dormant alfalfa that is established, or to new seeded alfalfa with three or more trifoliolate leaves. Application for control of chickweed and downy brome may be made from October through January using 1 to 2 quarts of the 4 EC. After the beginning of February, 2 to 3 quarts can be used. The rate for granules is 40 pounds per acre of the 10 G. Do not apply within 40 days of harvest. Do not apply to alfalfa mixed with grass.

## Grass Pasture Herbicides

Pasture weed control must be part of a total program of good management that includes proper grazing, good fertilization, and reseeding as necessary.

**2,4-D** at ½ to 1 pound per acre should provide adequate control of most broadleaf weeds. Higher rates may be needed for more resistant weeds such as perennials. Milk cows should not be grazed on treated land for 7 days after treatment.

**2,4,5-T** is more effective than 2,4-D on woody plants. It may be used alone or in combination with 2,4-D. Do not graze dairy cows on lands treated with 2,4,5-T for six weeks. Meat animals should not graze on pastures recently treated with 2,4,5-T within two weeks of slaughter. 2,4,5-T is illegal to use around waterways, recreation areas, and lawns.

**Silvex** will control most woody plants about as effectively as 2,4,5-T and does not have the same area restrictions. However, you should observe the same grazing restrictions as with 2,4,5-T.

## Specific Weed Problems

### Yellow Nutsedge

Yellow nutsedge is a perennial sedge and differs from grass in that it has a triangular stem. It can reproduce by seed, but mainly reproduces by tubers. Regardless of the soil depth at which the tuber germinates, a basal bulb develops 1 to 2 inches under the soil surface. A complex system of rhizomes (underground stems) and tubers develops from this basal bulb. For the most effective control, soil-applied herbicides should be incorporated to place them in the same soil layer in which this basal bulb is developing. Yellow nutsedge tubers begin sprouting about May 1 in central Illinois.

*For soybeans,* a delay in planting until late May allows two or three tillage operations to destroy many nutsedge sprouts. Tillage helps deplete food reserves in nutsedge tubers. Row cultivation and preplant applications of Lasso or Vernam will help suppress the nutsedge.

**Lasso (alachlor)** applied preplant incorporated at 2½ to 3½ quarts per acre (½ quart more than for surface-applied rates) can often give good control of nutsedge.

**Vernam 7E (vernolate)** applied at 3½ pints per acre is also effective against yellow nutsedge. Immediate incorporation is necessary with Vernam.

**Basagran (bentazon)** is a postemergence treatment that can also help control nutsedge in soybeans. Apply 1 quart per acre when nutsedge seedlings are small. A split application of two treatments of Basagran is cleared, but more weeds will be controlled with a program of Basagran postemergence after preplant incorporation of Lasso or Vernam.

*For corn,* preplant tillage is useless for controlling nutsedge sprouts, which do not appear until May 1. Timely cultivation is helpful in corn, but a program of herbicide plus cultivation has been the most effective nutsedge control.

**Eradicane (EPTC)** at 4¾ pints per acre is the most effective herbicide to control yellow nutsedge in corn. It must be incorporated immediately. **Sutan+**, **Lasso**, and **atrazine** can also be used to control yellow nutsedge. The combinations of Lasso or Sutan+ incorporated with atrazine also control many other broadleaf and grass weeds.

**Atrazine** or **Bladex (cyanazine)** as postemergence sprays are used to control emerged yellow nutsedge when it is small. However, their performance has been somewhat erratic. Split applications of atrazine plus oil have been more effective than single applications. **Lorox (linuron)** directed postemergence spray has also been effective, but is typically used for salvage operations.

### Johnsongrass

Johnsongrass is found primarily in the southern third of Illinois. It is often a serious problem where infestations occur. It is a perennial and can reproduce both from seeds and by rhizomes. Several herbicides can control seedlings, but the control of johnsongrass rhizomes should involve both chemical and cultural methods.

Much of the rhizome growth occurs after the johnsongrass head begins to appear. Mowing, grazing, or cultivation to keep the grass under 12 inches tall can significantly reduce rhizome production.

Johnsongrass control can also be improved with tillage. Fall plowing and disking can bring the rhizomes to the soil surface where many of them can be winterkilled. Disking also cuts the rhizomes into small pieces which makes them more susceptible to chemical control.

Rhizome johnsongrass can be controlled or suppressed using certain herbicides in various cropping programs (see below). Several preplant incorporated herbicides will provide adequate johnsongrass seedling control in soybeans or corn (see selectivity table below).

**Treflan (trifluralin)** used in a three-year soybean program has been fairly successful in controlling rhizome johnsongrass. Treflan is used at twice the normal rate each year for two years and then at the normal rate the third year before resuming a regular crop rotation. Research suggests that control may be 50 to 75 percent the first year and about 90 percent the second year.

**Eradicane (EPTC)** has given partial control of rhizome johnsongrass in corn. Preplant apply 7⅓ pints of Eradicane 6.7E per acre and incorporate immediately. Eradicane is better than Sutan+ for controlling rhizome johnsongrass, although both will control seedling johnsongrass.

**Dalapon** can be used to treat emerged johnsongrass before planting corn or soybeans. Apply 5 to 7 pounds per acre after the grass is 8 to 12 inches tall. Plow about a week later and then delay planting corn or soybeans about 2 weeks. See label for specific time intervals.

Dalapon can also be used to control johnsongrass after wheat that is not double-cropped. Combining a mowing, timely dalapon application, and tillage program has provided quite effective control of johnsongrass. However, much of the wheat acreage in the johnsongrass area is double-cropped.

**Roundup** (glyphosate) has given good control of johnsongrass. While it is not yet cleared for cropland use, clearance is expected early in 1976. Suggested rates are 2 to 3 quarts in the spring when johnsongrass has reached at least 18 inches and is actively growing. Or, if possible, delay application until most johnsongrass approaches the early head stage. It may be applied in the fall before johnsongrass turns brown. Three to 7 days should be allowed after application before tillage.

### Quackgrass

Quackgrass is a perennial grass primarily of northern Illinois. Most preemergence herbicides will not control it because it is a perennial.

**Atrazine,** however, is quite effective when used in a preplow and preplant or preemergence split application in corn. Apply 2½ pounds of atrazine 80W per acre in the fall or spring, and plow 1 to 3 weeks later. Another 2½ pounds per acre should be applied as a preplant or preemergence treatment. A postemergence application is possible, but is usually less effective. A single treatment with 3¾ to 5 pounds per acre can be applied either in the spring or fall 1 to 3 weeks before plowing, but the split application usually gives better control of annual weeds. If atrazine is applied at rates over 3¾ pounds per acre, do not plant crops other than corn or sorghum the following year.

**Eradicane** (EPTC) can be used to suppress quackgrass in corn where more flexibility in cropping sequence is desired. Use 4¾ pints per acre of Eradicane 6.7E on light infestations, and 7⅓ pints per acre for heavier infestations.

**Dalapon** can be applied to quackgrass 4 to 6 inches tall in the spring at a rate of 8 pounds per acre. Plow after 4 days and delay planting corn for 4 to 5 weeks. Up to 15 pounds of dalapon may be used in the fall.

**Roundup** (glyphosphate) appears promising for controlling quackgrass before planting either corn or soybeans. Clearance is expected early in 1976. Suggested rates will be 2 to 3 quarts per acre when quackgrass is 6 to 8 inches tall and actively growing (fall or spring). Delay tillage for 3 to 7 days after application.

### Canada Thistle

Canada thistle is a perennial weed and like most perennials it has large food reserves in its root system. Repeated cultivation or mowing can deplete the root reserves and may eventually kill Canada thistle. However, use of herbicides is usually easier, more effective, and more economical.

There are several varieties of Canada thistle. They differ not only in appearance but also in their reaction to herbicides.

**2,4-D** may give fairly good control of some strains. Rates will depend on where the thistle is growing. For example, higher rates can be used in grass pasture or in non-crop areas than in corn. **Banvel** is often a little more effective than 2,4-D for thistle control. **Amitrole or amitrole-T** is quite effective for control of Canada thistle, but can be used only in non-crop areas. Postemergence applications of atrazine and oil in corn have sometimes appeared fairly effective. **Tordon** gives good control of Canada thistle, but its use in Illinois is not usually recommended because of the extreme sensitivity of soybeans and some other broadleaf plants.

### Wild Garlic and Wild Onion

Wild garlic and wild onion are perennials that begin growing in the fall both from old plants and bulblets that have been produced in heads and drop to the soil. The plants remain green most of the winter. In May aerial bulblets begin to form on both wild garlic and wild onion. The plants mature about the same time as wheat, and by mid-July become dormant until fall rains encourage new growth anytime from September to November. The two plants appear similar, but wild garlic is probably the more widespread and more serious of the two in Illinois. They are usually not serious in cultivated row crops such as corn or soybeans where adequate tillage is used. The greatest problem is in winter wheat due to dockage of grain contaminated with the aerial bulblets of garlic or onion. With the large dockages on wheat contaminated with wild garlic and wild onion bulblets, control of these weeds has become very profitable.

Wild garlic and wild onion can usually be controlled quite well by growing crops which can be plowed in late fall or early spring. This plowing combined with cultivation during May and June can greatly reduce the growth and reproduction of these weeds. Growing corn or soybeans with adequate tillage for three or four years can greatly reduce, if not eliminate, the problem of wild garlic and wild onion.

**2,4-D** can be sprayed in the spring after tillering, but before grains reach boot stage. If the herbicide is applied earlier, tiller production may be reduced. Spraying during the boot stage, when the very young wheat head is still inside the stem, may also cause injury to the wheat and reduce yields. The proper time for spraying winter wheat is usually late March or early April. Use ½ to 1 pound of 2,4-D ester or ¾ to 1½ pounds of 2,4-D amine. Wild garlic control has been better with 2,4-D ester than with 2,4-D amine. These rates may reduce wheat yields and will probably kill legume underseedings. Only about ⅓ to ½ of the wild garlic or wild onion will be killed, but the remaining plants may be so distorted that the combine can be set to miss most of the aerial bulblets.

**Banvel (dicamba)** is also cleared but the legal rate in wheat is too low for effective control of wild garlic. Banvel K is a formulated mixture of dicamba plus 2,4-D amine. See wheat section for more information about the use of Banvel and Banvel K on small grains.

In grass pastures, 1 to 2 pounds of 2,4-D ester applied in late fall or early spring has sometimes given effective control. Where it can be used with appropriate precautions, dicamba (Banvel) is sometimes as effective as 2,4-D. In wheat, however, the legal rate and crop tolerance make 2,4-D ester a better choice.

## Additional Information

Not all herbicides and herbicide combinations available are mentioned in this publication. Some are relatively new and still being tested. Some are not considered to be very well adapted to Illinois or are not used very extensively. For other information on field crop weed control, write to the Department of Agronomy, W-201 Turner Hall, University of Illinois, Urbana, Illinois 61801.

### Relative Effectiveness of Herbicides on Major Weeds

This chart gives a general comparative rating. Under unfavorable conditions some herbicides rated good or fair may give erratic or poor results. Under very favorable conditions control may be better than indicated. Type of soil is also a very important factor to consider when selecting herbicides. Rate of herbicide used will also influence results. G = good, F = fair or variable, and P = poor.

| | Control for Soybeans | | | | | | | | | | | | Control for Corn | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PREEMERGENCE Amiben | Lasso | Lasso + Dyanap | Lasso + Lorox | Lorox | Modown | Sencor, Lexone | Treflan, Tolban, Cobex | Vernam | POSTEMERGENCE Basagran | Tenoran, Norex | 2,4-DB | PREEMERGENCE AAtrex, atrazine | Bladex, Cycle | Lasso | Lasso + atrazine | Princep + atrazine | Prowl | Ramrod, Bexton | Ramrod + atrazine | Sutan, Eradicane | Sutan + atrazine | POSTEMERGENCE AAtrex + oil | Banvel | 2,4-D | Bladex |
| **Crop tolerance** | F-G | G | F | F | F | F | F | F-G | F | F-G | F | F | G | F-G | G | G | G | F | G | G | F-G | F-G | F-G | G | F-G | F-G |
| **GRASSES** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Foxtail** | G | G | F-G | G | F-G | F | F | G | G | P | P | P | F-G | F-G | G | G | F-G | G | G | G | G | G | F-G | P | P | G |
| **Barnyard grass** | F-G | G | F-G | G | F-G | F | F | G | G | P | P | P | G | F-G | G | G | G-F | G | F | F | G | G | G | P | P | G |
| **Crabgrass** | F-G | G | F-G | G | F-G | F | F | G | G | P | P | P | P | F-G | G | G | F | G | G | G | G | G | P | P | P | F |
| **Fall panicum** | F-G | G | F-G | G | F-G | F | F | G | G | P | P | P | P | G | G | G | F | G | F | F | G | G | P | P | P | F |
| **Johnsongrass seedlings** | F | P-F | P | P | P | P | P | G | G | P | P | P | P | P | P-F | P | P | F | P | P | F | F | P | P | P | P |
| **Shattercane** | F | P-F | P | P | P | P | P | G | G | P | P | P | P | P | P-F | P | P-F | F | P | P | F | F | P | P | P | P |
| **Yellow nutsedge** | P | F | P | P-F | P | P | P-F | P | F | F | P | P | F | P | F | F | P | P | P-F | P-F | F | F | F | P | P | F |
| **BROADLEAVES** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Annual morningglory** | P | P | F | P | P | F | P | F | F | P | F | F | G | F | P | F-G | F-G | P-F | P | F-G | P | F-G | G | G | G | G |
| **Cocklebur** | P-F | P | F-G | F | F | P | F | P | P | G | F | G | F-G | F | P | F-G | F-G | P | P | F-G | P | F-G | G | G | G | F |
| **Jimsonweed** | P-F | P | G | F | F | G | F-G | P | P | G | F | P | G | G | P | G | G | P | P | G | P | G | G | G | F | G |
| **Lambsquarters** | G | F | G | G | G | G | G | G | F | F | F | P | G | G | F | G | G | G | F | G | P | G | G | G | G | G |
| **Pigweed** | G | G | G | G | G | G | G | G | G | F | F | P | G | F | G | G | G | G | G | G | G | G | G | G | G | F |
| **Ragweed, common** | G | P-F | G | G | G | F | G | P | P | G | F | F | G | G | P-F | G | G | P | P | G | P | G | G | G | G | G |
| **Ragweed, giant** | F | P | F | F | F | P | F | P | P | F | F | F | G | G | P | F | G | P | P | F | P | F | F | G | G | F |
| **Smartweed** | F-G | P-F | F-G | G | G | G | G | P-F | P | G | F | P | G | G | P-F | G | G | F | P | G | P | G | G | G | P-F | G |
| **Velvetleaf** | F | P | F | F | F-G | F | G | P | F | F | P | P | F-G | F | P | F | F | F | P | F | F | F-G | F-G | F | F | F |

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