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Winter WHEAT CULTURE *in Michigan*

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EAST LANSING

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Winter Wheat Culture in Michigan

H. M. BROWN AND E. E. DOWN

Wheat was Michigan's first important grain crop and has continued to be an important product of this state. In 1866, when the first crops estimates[1] were issued, wheat was found to be grown on slightly more than 1,000,000 acres. During the early eighties this acreage rapidly expanded to almost 2,000,000 acres. The development of Michigan's dairy and livestock industry, calling for a greater production of feed crops, such as corn, oats, and hay, together with an increased production of beans, potatoes, and sugar beets, brought about a reduction in wheat acreage by 1903 to less than 1,000,000 acres. Since then the acreage of harvested wheat has gone above the million mark only seven times and has dropped below 800,000 nine times. Apparently there is a tendency toward stabilization around 900,000 acres.

No such conditions are observed in yield in bushels per acre. Over the 71 years for which records are available, the yields per acre have increased from 14.8 up to 19.3 bushels. This is a gain of 4.5 bushels per acre or a 30 per cent greater yield per acre than was obtained in the late sixties.

The wheat acreage is not uniformly distributed over the state, but is confined largely to the southern part of the lower peninsula, as may be seen in Fig. 1. More than 90 per cent of the winter wheat crop of this state is grown south of a line drawn through Muskegon and Bay City. The average yield per acre by counties for the last 25 years (1912-'36) is shown in Fig. 2. In general, the areas of highest production per acre are seen to be in the Saginaw valley and bay region and the southeastern lake-bed counties. The area of lowest yields per acre is the southwestern section where the sandier types of soil prevail.

TYPES OF SOIL FOR WHEAT

Winter wheat yields well when grown on soils with good drainage and rather high fertility. In general, these soils include, at one extreme, light sandy loams, such as found in the southwestern district, and, at the other extreme, the heavier silt and clay loams such as are found in the old lake-bed regions in the east central and southeastern districts.

Winter wheat should not be grown on muck nor on very light sandy soils. On the mucks, heaving, due to the freezing and thawing action

[1]The data on acreages and yields were obtained from the Agricultural Statistician of the U. S. Department of Agriculture in Lansing, Mich., and are revised to Jan. 1, 1937.

in the soil, is so great that large percentages of the stand are killed. On the very light, sandy soils, there is not enough organic matter to hold moisture and plant food to allow the young wheat plants to get an adequate start in the fall nor to allow the plants that survive until spring to produce enough to make the crop profitable.

The two classes of wheat which are grown successfully in Michigan belong to the soft red winter and soft white winter types. The kernels of these two groups are larger than those of the hard red winter or hard spring wheats. The texture is starchy rather than vitreous, a condition induced by the humid climate of the wheat producing section of the state. The gluten is medium in strength for the red varieties and weak for the white types. That accounts for the uses to which flours from those wheats are put. The soft red winter sorts

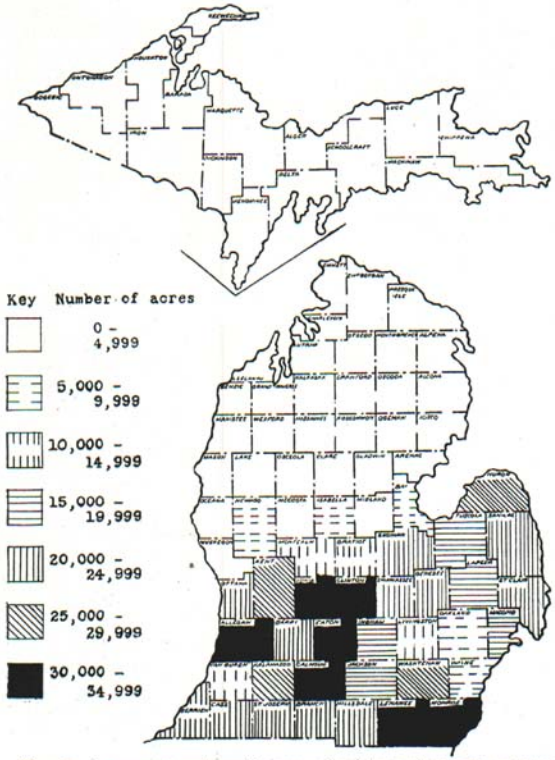

Fig. 1. Average number of acres of winter wheat per county based upon data taken from the United States census of 1920, '25, '30, and '35.

are milled either unblended or blended with the stronger western wheats, and the flours in either case are excellent as all-purpose flours, provided appropriate methods of baking are used. The soft white winter wheats with their weaker gluten are milled most extensively for use in the pastry, baking-powder biscuit and cracker trade.

The distribution of those two main classes of soft winter wheat was studied recently by H. C. Rather, head of farm crops at Michigan State College, with the aid of the agricultural teachers in the high schools of the wheat belt. It was found that the white types were grown more extensively in the "thumb" district and the red types in the southwestern district. The distribution is shown by Fig. 3.

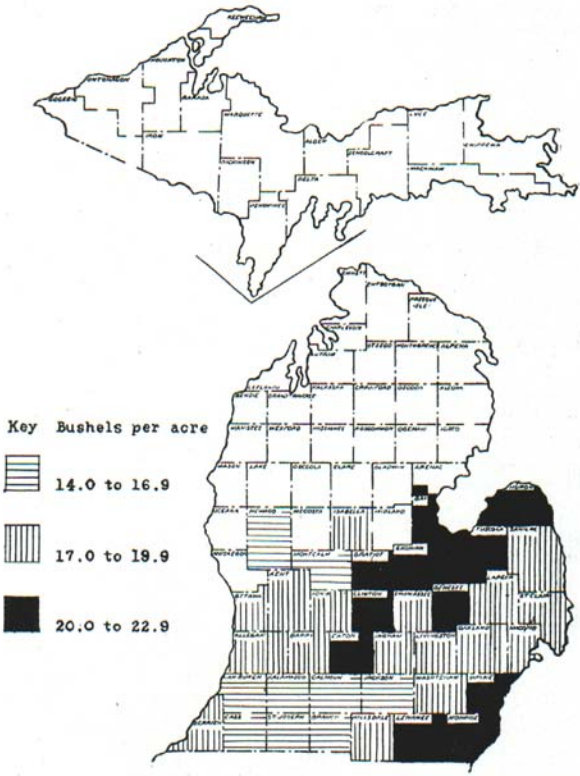

Fig. 2. Average yield, in bushels per acre, of winter wheat for the 25 years, 1912 to 1936. No yields are given for counties having fewer than 5,000 acres. Data for 1912-'21 taken from Annual Crop Report for 1922, and for 1922-'36 from yearly Crop Report for August of the respective years.

RECOMMENDED VARIETIES

The variety trials on the Experiment Station plots at East Lansing, and the over-state tests have indicated that there are few varieties of winter wheat which can be strongly recommended for Michigan's wheat belt. These are:

Soft white winter:

American Banner—which is bald and has brown (red) chaff.

Soft red winter:

Baldrock—which is bald and has brown (red) chaff.
Red Rock—which is bearded and has brown (red) chaff.

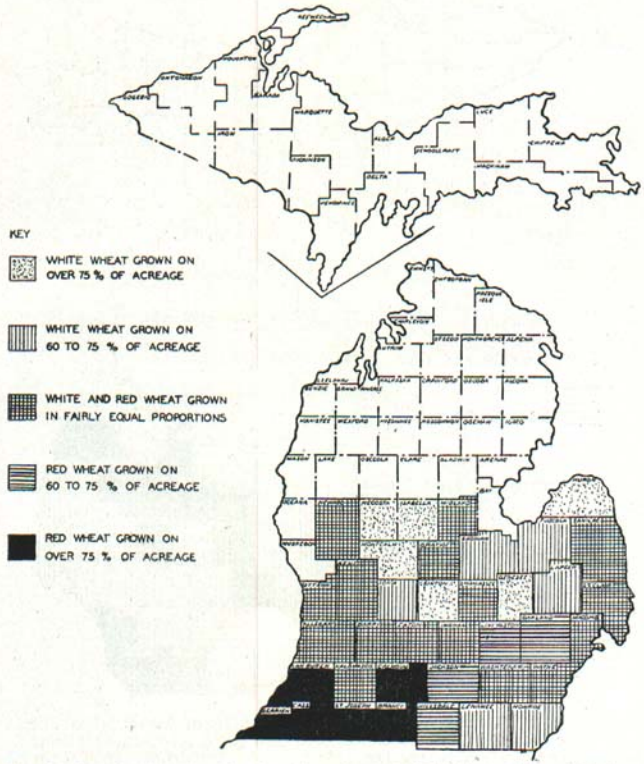

Fig. 3. Distribution of red and white wheats in Michigan. (From Mich. Agri. Exp. Sta. Quart. Bul. 18: 266-8, No. 4, May, 1936.)

All three of these varieties have comparatively stiff straw with Baldrock having somewhat the stiffest and American Banner next. In point of winter-hardiness, these three are considered winter-hardy for Michigan with Baldrock leading and American Banner next. As to yield, these three varieties are very similar.

The characteristics which a wheat must have to be recommended are: winter-hardiness (see Fig. 4), stiff straw, and high yield of grain of proper quality. In the breeding work at East Lansing, an attempt is being made to obtain a variety with not only these characteristics, but also resistance to various diseases.

Fig. 4. Winter-hardiness is necessary in wheats grown in Michigan. The unadapted variety, Redhart, showed only 10 per cent survival, May 6, 1937, following a very mild winter. Baldrock and American Banner showed 100 per cent survival.

"RUNNING OUT"

The experience of having a wheat variety "run-out" can nearly always be traced to one or a combination of three factors: (1) planting unadapted seed; (2) mixing with an inferior variety; or (3) failing to maintain soil fertility.

SEEDBED PREPARATION

A desirable seedbed for wheat has a fine mellow surface but is compact beneath. The cultural practices necessary to attain this condition, of course, will vary from farm to farm depending upon the type of soil, the previous crop, weather conditions, and the equipment available. In one case, the operations involved may include plowing, cultipacking, disking and dragging, or in another case only disking.

When wheat follows a grain crop, the field should be plowed as soon as the grain crop is removed. When wheat follows a cleanly cultivated crop, only disking may be required to loosen the top soil.

FERTILIZERS

The kind and amount of fertilizer to apply to a given field depends on the type of soil and its previous management. Adequate discussions of these conditions are available in the several publications from the Soils Section of the Michigan Agricultural Experiment Station, among which are: Ext. Bul. 71 (revised), "Farm Manure—Value and Care"; Spec. Bul. 91 (revised), "Lime for Sour Soils"; Spec. Bul. 133, "Fertilizers—What They Are and How to Use Them"; and the extension bulletin, issued yearly, which gives the fertilizer recommendations for that year.

Fig. 5. Advanced variety yield series at East Lansing. The strains which have been judged as possessing the desirable characteristics of stiff straw, winter-hardiness, uniformity of height and maturity, high yielding ability, and acceptable quality of flour are grown in advanced series such as this.

SEED PREPARATION

Wheat to be used for seed should be thoroughly fanned and screened to remove dirt, weed seeds, chaff, shrivelled and broken kernels, and smut balls.

This cleaning process should then be followed by some treatment of the seed to control bunt (stinking smut). For description of disease, see page 15. Various dust disinfectants for this purpose have been tried. Improved Ceresan and copper carbonate are the two recommended. These dusts may be applied with a drum-mixer[2] or a cement mixer with tight fitting cover. The mixer should be rotated slowly and sufficiently to mix the dust and grain thoroughly—50 turns, or from two to four minutes. Shovel treatment is not so effective as a drum mixer. Care must be exercised to do the mixing and sacking of treated grain in the open or under cover where there is a draft of air. "Every reasonable effort should be made to avoid inhaling the poisonous dusts or bringing them in contact with the skin. Persons

[2]For home-made mixer, see Mich. Agr. Exp. Sta. Ext. Bul. 176, Oat Smut Control.

perspiring should avoid having their moist skin come in contact with such materials."[3]

(a) **Improved Ceresan** is an organic compound which effectively controls not only bunt, but also scab. It is most effectively applied with a drum mixer. The rate of application is ½ ounce per bushel of grain and **over-dosage must be avoided** or germination of grain may be reduced. Follow directions on the container.

(b) **Copper carbonate**—either dilute, 18-20 per cent copper, or concentrated, 50 per cent copper—has been used longer than other dusts and both forms give effective control. The dilute form is applied at the rate of 3 to 4 oz. per bushel of grain, while the rate for the concentrated form is 2 to 3 oz. per bushel. Copper carbonate has the advantage over other dusts of not reducing the germination of the treated grain even though such grain be stored for a year. The objection to the use of this dust arises from the fact that the "extra" dust which settles into the drill parts as the grain is drilled, tends to take on moisture and becomes cement-like. The result of this is the "locking" of the drill parts. To minimize this difficulty, avoid overdosage and clean the drill thoroughly and immediately after planting. The cleaning is to remove all copper carbonate dust from the moving parts of the drill. When the drill is next used, it should be tried out, by rotating a wheel by hand to determine whether "locking" has occurred.

RATE OF PLANTING

Yield of grain per acre is affected by the rate of planting as is shown by the results obtained from a rate of planting test conducted by F. A. Spragg and E. E. Down at East Lansing, in 1919, 1920, 1921.

Rate per acre		Yield per acre	Yield less seed planted
pecks	bushels	bushels	bushels
3	0.75	15.50	14.75
4	1.00	16.03	15.03
5	1.25	18.07	16.82
6	1.50	19.48	17.98
7	1.75	20.53	18.78
8	2.00	19.88	17.88

It is seen that as the rate increases from 3 up to and including 7 pecks per acre, the yield also increases, but that when the rate is increased still further, the yield actually drops. In other words, a more effective use of the available plant food and moisture was obtained

[3]U. S. Dept. Agr. Cir. 415, Equipment for Applying Dust Fungicides to Seed Grain.

by increasing the number of plants per acre up to a certain point. The turning point for this test is between 6 and 7 pecks per acre.

DEPTH AND METHOD OF PLANTING

Wheat should be planted as shallow as possible and yet at such a depth that it is completely covered. On the heavier soils an average depth of one inch is preferable to 2 or more inches; on the lighter soils a depth of 1½ to 2 inches is desirable.

Higher yields of grain are obtained by planting the grain with a grain drill than by sowing the seed broadcast and covering by dragging.

DATE OF PLANTING

The date of planting winter wheat ranges from the first week in September, in Cheboygan County, to the last week in September, in Hillsdale County. Two of the factors which are usually considered in

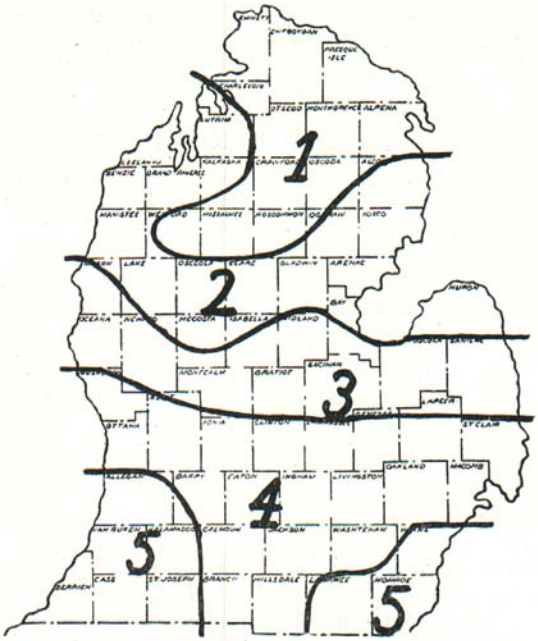

Fig. 6. Average Hessian fly-free dates for the lower peninsula based on the low altitude data given in Mich. Agr. Exp. Sta. Spec. Bul. 183, revised. The dates for the five regions shown are as follows: 1—Sept. 6 to 9; 2—Sept. 10 to 13; 3—Sept. 14 to 16; 4—Sept. 17 to 19; and 5—Sept. 20 to 23.

deciding on the date to plant are the "fly-free" date and the date after which the wheat plant will not make sufficient growth to survive the winter.

The fly-free date varies but little from year to year and is that date after which wheat may be planted with some assurance that it will be free from Hessian fly fall infestation and injury. The general rule given by A. D. Hopkins of the United States Dept. of Agriculture is that the fly-free date is "when the foliage of ash, birch, dogwood, and hickory begins to turn color, in regions where winter wheat is planted." The calendar dates are shown in Fig. 6. Wheat planted before the earliest of the dates for a given section is much more likely to become fall-infested with this fly than when planted after these dates.

In the spring, the fly emerges from its pupa, or "flaxseed," which has wintered-over in early fall-planted fields and causes spring infestation not only in the field from which it emerged, but also in neighboring fields which were planted after the fly-free date. The larvae from this spring brood form puparia ("flaxseeds") between the leaf sheath and stem at one of the joints near the ground and weaken the stem at this place. Stems which are thus weakened tend to break over with a consequent loss of grain.

While wheat should not be planted before the fly-free date one must not go to the other extreme and delay too long before planting, because the seedlings require some time to become well-established for the winter. (See Fig. 7.) No set dates can be given after which wheat should not be planted, because soil and climatic conditions vary greatly from place to place, and there is a variation in weather from year to year. The general recommendation, however, is to get the wheat sown as soon after the fly-free date as possible. The combined results from the date of planting tests, conducted by F. A. Spragg and E. E. Down at East Lansing in 1919, 1920, and 1921 are as follows:

Date Planted	Yield in Bushels per Acre
Sept. 15 to 17	18.5
18 to 22	19.0
25 to 30	14.2
Oct. 1 to 13	13.1

Those results indicate that there is a period during which wheat should be planted to get maximum returns per acre and that after that time yields drop materially.

FALL PASTURING

Occasionally weather conditions are such that a large top growth is produced in the fall. If there is a shortage of fall pasturage, the

wheat field may be pastured, provided care is taken not to over-pasture. The seedlings should have approximately three inches of top growth left to enable them to withstand winter-killing.

TOP-DRESSING

There are two kinds of fertilizers which, under certain conditions, may be used successfully as top-dressings on wheat: (a) barnyard manure and (b) commercial nitrogen fertilizer. Top-dressing should not be applied (a) when an alfalfa or clover seeding is grown with wheat because the seeding tends to be smothered by the vigorously growing grain crop; nor (b) when the soil is high in fertility as lodging will be more likely to occur. These dressings are more beneficial to wheat grown on the lighter soils than on the heavy soils.

Fig. 7. The effect on the stand and vigor of wheat due to planting late is clearly shown in the above picture which was taken May 5, 1937. The vigorous rows were planted September 22, while the less vigorous rows were planted October 12.

The benefits from top-dressing are an increase in growth early in the spring and an increase in yield of grain and straw.

Barnyard manure may be applied any time during the winter while the ground is frozen enough to hold up team and spreader and should be applied at a rate of 4 to 6 tons per acre.

SEEDING A LEGUME WITH WHEAT

Seeding alfalfa or one of the clovers on wheat should not be attempted on soils low in fertility and humus, nor should it be done when the wheat is top-dressed either with manure or commercial nitrogen fertilizer.

Seeding a legume on wheat may be successful on the heavier soils, if the seeding is done early enough in the spring so that the young legume plants may become established before the ground is entirely

shaded by the wheat. It may be done while the ground is still frozen, trusting to the freezing and thawing of the soil and to the spring rains to cover the seed; or, preferably, it may be done as soon after the frost goes out of the ground, as a team and drag can be used to cover the seed. If seeding is done by grain drill or grass seeder, then it must be done as soon as the ground is firm enough to hold up team and drill, but before the wheat has acquired much top growth. Whatever method is used, the rate of seeding is 8 to 10 lbs. per acre.

If alfalfa or clover is not seeded in the spring, the wheat ground may be disked and planted to field peas in August.

CUTTING OUT WEEDS

During the latter part of the growing season, thistles, dock, cockle, rye, and chess (also called cheat) should be pulled or spudded out. Much labor will be saved in cleaning the grain for seed purposes if this practice is followed.

BINDER HARVESTING

When the grain is in the thick to hard dough stage and the straw has lost its green color, but is not yet fully dry, it is time to begin cutting with a binder. If the acreage is so large that several days will be required to cut it all, cutting may be begun a little on the "green" side. Harvesting may begin early in the morning and continue until late at night provided the straw is dry enough to go through the binder without clogging.

The bundles of grain may be left in the field in capped round shocks until threshing time or until put into the stack or barn. In any case, the straw and grain should be allowed to dry thoroughly before threshing. The completion of the maturing of the grain occurs during this period and is accompanied by what is termed "sweating". "Sweating" is the giving off of moisture by the wheat kernels during the final stages of maturing and curing. If this takes place in the shock and stack, no damage is done to the grain; but if it does not take place until after threshing, then care must be taken to see that the grain does not become over-heated, with resultant binburn and mustiness.

COMBINE HARVESTING

Recently, combining (harvesting and threshing in one operation) wheat has become an established practice in the humid or eastern central states, like Michigan. This has occurred because small, lightweight combines suitable for the small fields found in these eastern states have been manufactured and because it has been observed that there have been at least a few days during the three weeks following normal binder harvest when the standing grain was dry enough to cut and thresh in one operation.

Windrowing the grain, as is done with barley and oats, and then picking up the windrow with a combine is not practiced with wheat because wheat can stand uncut for long periods after ripening without great loss.

Combining wheat in the humid sections of the country has problems not confronted when harvesting with a binder. Some of these are: the shorter length of day that combining can be done; handling of straw; the losses due to shattering after standing grain is dead-ripe; the moisture content of grain before it can be safely combined and stored; and the effects on test weight of allowing the grain to stand in the field.

Length of Cutting Day—While binder harvesting may be done throughout the day from early morning to late evening, it has been found by experience that any dampness, dew or rain, which toughens the straw is enough to prevent combining. This has meant that the operation of the combine is limited to fewer hours of the day.

Handling of Straw—If straw is needed for bedding, and combining is practiced, the straw may be left in a windrow and picked up with a hay loader.

If the straw is not needed, the combine furnishes a labor saving means of putting the straw back onto the land to maintain the organic content of the soil.

Losses Due to Shattering—Delayed harvest studies, conducted at East Lansing, on the 1930 to 1933 crops indicate that in three of those four years there were no appreciable losses in yield of grain when the grain was left standing in the field from two to three weeks after normal binder-harvest time.

Safe Moisture Content—During the first week of standing in the field, after it was ready for binder harvesting, the moisture in the grain rapidly dropped from 30 per cent to 15 per cent and leveled out around 12 per cent. Other tests have indicated that grain containing less than 14 per cent moisture can be combined without danger of overheating or becoming musty. Grain with higher moisture content is likely to damage from heating and mold unless thoroughly dried out shortly after combining.

Test Weight—In these delayed-harvest studies when the grain was allowed to stand in the field for long periods of time, there was a drop in test weight per bushel. This drop was found to be associated with the amount of rainfall during that period and was sufficient to lower the grade from No. 2 to No. 3. This same drop in grade may also take place in grain that is left in shocks for too long a time during rainy weather. The reason for this drop is not a deterioration of the kernel contents, but rather that the fully mature kernel takes on moisture during wet periods and swells, stretching the bran seedcoat somewhat. As the kernel dries, the bran layer does not shrink back to its previous size and hence there is less weight of grain per unit volume than before the swelling took place. This explanation has been verified by laboratory tests involving the wetting of mature dry grain and then letting the samples dry.

The test weight results from the last two years[4] of the delayed harvest tests for the period after binder harvest are as follows:

[4]Data from Mich. Agr. Exp. Sta. Quart. Bul. 18: 89-91, No. 2, Nov., 1935.

Date	Test Weight in Lbs. per Bu.		Total Inches of Rain Since Binder Harvest
	American Banner	Baldrock	
1932, July 11*	—	—	—
14	59.2	60.8	0
19	58.7	60.6	0
25	58.4	60.3	0
Aug. 3	56.5	58.5	1.47
11	56.2	58.1	1.72
1933, July 7*	—	—	—
8	57.0	59.7	.06
19	56.0	58.5	.31
31	54.9	57.4	.91
Aug. 5	54.8	56.7	2.29
12	54.7	57.3	2.54
19	54.1	56.8	2.86

*Date of binder harvest.

It is seen from these figures that when there was but little rainfall after normal binder harvest as in July, 1932, there was but little drop in test weight. It is also seen that when rain began, the test weight dropped. The same was true in 1933, except the rains occurred throughout the delayed harvest period and the drop in test weight occurred early.

DISEASES[5]

During certain seasons, particular diseases may be severe enough and distributed widely enough to cause great losses in the wheat crop, but other seasons those same diseases may do scarcely any damage. Nearly all methods looking toward the control of wheat diseases attack the problem from the viewpoint that the disease must be prevented rather than cured after it has started. There are two general methods of prevention: first, control by the use of various treatments, and second, the breeding of strains immune or resistant to the disease.

DISEASES NOT CONTROLLED BY TREATMENT

Leaf rust *(Puccinia triticina)* attacks the leaves and has orange-red spores in oval pustules. The leaves are killed and dry prematurely, causing the grain to be shrivelled. In severe epidemics the ground may take on a reddish hue and the clothing of a person walking through the field will become rusty-red in color because of the rust spores.

Stem rust *(Puccinia graminis)* is unlike leaf rust in that the spores in the early part of the summer are reddish brown instead of orange-red in color, and the pustules, which are long and narrow occur primarily on the stem and leaf-sheaths. As the wheat plant approaches maturity, the pustules change color from reddish brown to black due to the formation of the winter spores. The losses due to an attack of stem rust may be large because this rust destroys the tissues in the

[5]For more detailed descriptions of diseases see Mich. Agr. Exp. Sta. Cir. Bul. 142, Common Diseases of Cereals in Michigan.

stem which are used to transport the materials to the kernels in the head. If the disease appears early, small shrivelled grain may be expected. It it does not appear until near maturity, slight, if any, damage will be done.

DISEASES NOT EASILY CONTROLLED BY TREATMENT

Loose smut *(Ustilago tritici)* is most noticeable just at heading time. It is then that heads infected with loose smut show their characteristic black, easily-blown-away smut spores. Within two weeks after heading, the spores blow away leaving only the naked stem as evidence of the disease. Losses vary from negligible amounts up to 5 per cent of the crop. This disease may be controlled by what is known as the hot water treatment, a treatment which requires very careful manipulation of temperature to control the disease without killing the seed. Treatment is not recommended unless temperature controlled steam vats are available.

Powdery mildew *(Erysiphe graminis)* is most in evidence during wet weather, in the spring and early summer, on the lower leaves of the plant. It gives the top-sides of leaves a grayish moldy appearance due to the fungous threads. The starch-manufacturing parts of the plant are destroyed with the result that yield of grain may be reduced greatly. No practical control measure has yet been worked out.

DISEASES EASILY CONTROLLED BY TREATMENT

Bunt or stinking smut *(Tilletia laevis* and *Tilletia tritici)* is easily distinguished at harvest time by its fish-like odor, if there is a large amount of it, or by the smut balls and black spore dust in the threshed grain. The **smut balls** are lighter in weight, shorter in length and plumper in girth than sound grain and when crushed, show a mass of black spores. The black smut spores cannot be seen until the smut balls are broken in threshing. Methods of control are given on page 8.

Scab *(Gibberella saubinetti)* effects the head, grain, and seedlings. Infected portions of the head turn straw color and infected kernels are lighter in color and pithy in texture. Infected seedlings may not emerge or, if they do, are weak and spindling. Control involves seed treatment with Improved Ceresan, as mentioned on page 8 and not planting wheat on ground which has just grown a crop of scab-infected corn.

CONTROL OF DISEASES BY BREEDING

For each of the widely distributed diseases which attack wheat, there have been found varieties which are resistant, if not immune, to the disease. The problems for the plant breeder are to transfer these desirable inherited tendencies for resistance from one variety to another. This is necessary because the wheats which have good agronomic characters, such as winter-hardiness, stiff straw, earliness, and high yield, may not have resistance for all diseases, if for any. Some progress along this line has been made but not enough to warrant the release of new strains adapted to Michigan conditions.

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