6-1905

Winter Wheat: Cooperative Experiments with the United States Department of Agriculture

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BULLETIN No. 89.

THE UNIVERSITY OF NEBRASKA

BULLETIN

OF THE

AGRICULTURAL EXPERIMENT STATION

OF

NEBRASKA.

VOLUME XVII, ARTICLE V.

WINTER WHEAT.

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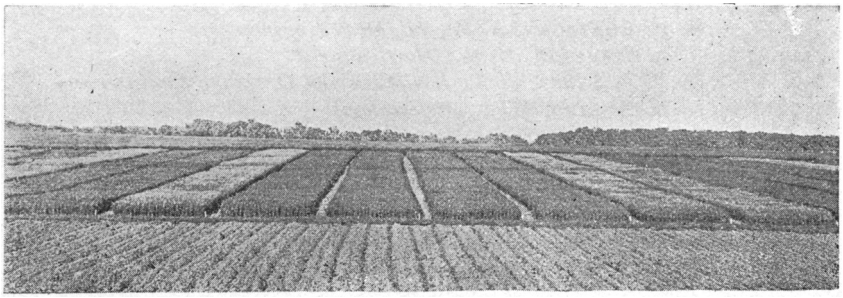
COOPERATIVE TESTS OF KHARKOF AND BEOGLINA WHEATS.
NATURE AND CAUSES OF "YELLOW BERRY" IN HARD WINTER WHEAT.
"RUNNING OUT" OF SEED WHEAT.
IMPORTANCE OF GOOD TILLAGE.
VARIATIONS IN WHEAT FROM DIFFERENT REGIONS AND IN DIFFERENT SEASONS.

BY T. L. LYON AND ALVIN KEYSER.

JUNE 1905



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WINTER WHEAT.

Cooperative Experiments with the United States Department of Agriculture.

T. L. LYON (*Nebraska Agricultural Experiment Station*).
ALVIN KEYSER (*U. S. Department of Agriculture*).

VARIETY TESTS OF WINTER WHEAT IN 1902, 1903, AND 1904.

The varieties of wheat tested were, in general, hard red winter wheats having some qualities that recommend them for use in this region. Four varieties were from Hungary and a larger number were from Russia.

The Hungarian wheats are of excellent quality, but mature late, which reduces their yield. They are improving in this respect. It is hoped that they will gradually adapt themselves to the requirements of the climate, and finally ripen in time to avoid the hot, dry weather which interferes with the proper development of wheat in midsummer. They exhibit a fair degree of resistance to cold, and in that respect can be said to be adapted to the region south of the Platte.

The Russian varieties are, in the main, hardy, and some of them extremely so. The latter are late maturing, and unless they change in this respect, will always be at a disadvantage. The farther north they are raised the less the injury from late maturity.

Almost all the varieties of which tests are reported in this bulletin have been tested for a number of years. Their previous records will be found in Bulletin 72 of this Station.

TESTS DURING 1902.

Table I shows the results of the plat tests for the year 1901–1902.

The varieties were planted with a press drill September 18, 1901.

TABLE I.—*Variety test, 1902.*

Variety.	Years grown in Nebraska	Stand.	Winter-killed.	Lodged.	Rust.	Scab.	Date headed.	Date ripe.	Yield per acre.	Weight per bu.	Quality.
Turkish Red...	6	Good	None.....	Little	Little	None	May 19....	June 23....	33.2	58.0	Extra
Crimean [1].....	3	"	Slightly	"	"	"	May 19....	June 24....	29.2	61.5	"
Crimean [2].....	3	"	None.....	"	"	"	May 19....	June 24....	29.1	61.5	Very good
Weissenburg...	3	"	"	"	"	"	May 19....	June 24....	26.7	59.5	Extra
Girka	3	"	"	"	"	"	May 19....	June 24....	26.2	60.5	Very good
Theiss.....	3	"	Very slightly.....	"	"	"	May 20....	June 24....	25.0	59.0	Good
Banat	3	"	Slightly	"	"	"	May 20....	June 24....	23.6	60.0	"
Ulta.....	3	"	None.....	"	"	"	May 15....	June 24....	22.6	60.0	Very good
Kharkof.....	3	"	"	"	"	"	May 19....	June 24....	22.3	58.0	Medium
Padi	3	"	"	"	"	"	May 22....	June 28....	16.6	54.5	"
Yaroslav [3].....	3	"	"	"	"	"	May 19....	June 30....	16.6	53.0	Extra
Yaroslav [4].....	3	"	"	"	"	"	May 19....	June 30....	16.0	50.0	Medium
Sandomir.....	3	"	"	"	"	"	May 19....	July 3....	14.5	50.5	"
Big Frame.....	6	"	Killed in patches.	"	"	"	May 12....	June 21....	10.8	52.1	Poor

[1] From central Crimea. [2] From northern Crimea. [3] From Yaroslav, Russia. [4] From St. Petersburg, Russia.

The winter of 1901–1902 was comparatively mild, but it was followed by a very early, dry spring with severe dust storms. The season was more favorable later, owing to abundant rains. All of the plats were injured by chinch bugs.

Big Frame, which had given such good promise in the previous tests, suffered most during the winter and spring.

All varieties were unusually free from diseases, probably due to favorable weather conditions.

Turkish Red, which had been grown on the Station farm for a number of years, gave the best yield, though it was surpassed in quality by a number of varieties. Theiss (a Hungarian wheat), two different importations of Crimean, and Ulta and Girka of the Russian wheats, were of better quality.

The most promising varieties were continued in 1902–1903. The poorer kinds, those which were deficient in hardiness, yield or quality, were discarded as not worthy of the expense of further trial.

Table II shows the results in the order of the yield per acre.

TABLE II.—*Variety test, 1903.*

Variety.	Years grown in Nebraska.	Stand.	Winter-killed.	Lodged.	Rust.	Scab.	Date headed.	Date ripe.	Yield per acre.	Weight per bu.	Quality.
Turkish Red...	7	Good	Very slightly .	Little...	Medium	None ...	June 4	July 10	32.6	60.5	Extra
Banat	4	Fair .	Badly	" ...	Little...	Little...	June 4	July 10	32.3	61.0	Good
Beloglina.....	4	Good	Somewhat	" ...	" ...	" ...	June 4	July 9	32.1	61.0	Extra
Weissenburg...	4	Fair .	"	" ...	" ...	" ...	June 4	July 10	31.0	61.5	Superior to any
Malakoff	1	Good	None	Medium	Medium	" ...	June 4	July 10	30.3	60.0	Extra
Pester Boden...	4	Fair .	Badly	Little...	Little...	" ...	June 4	July 10	30.0	62.0	Extra
Theiss.....	4	" .	"	" ...	" ...	" ...	June 4	July 10	30.0	60.5	Good
Winter Fife....	4	" .	Severely	Badly ..	Bad.....	Medium	June 4	July 10	29.3	57.5	Medium
Crimean [1].....	4	Good	None	Little...	Little...	Little...	June 4	July 9	28.5	58.0	Fair
Crimean [2].....	4	"	"	" ...	" ...	" ...	June 4	July 9	28.0	58.0	Extra
Big Frame.....	7	Fair .	Slightly.....	" ...	Medium	Very bad	June 4	July 6	27.6	58.5	Poor
Ulta.....	4	Good	"	" ...	Little...	Little...	June 4	July 10	27.6	60.0	Good
Girka	4	"	Killed in small spots	Medium	Bad.....	Medium	June 4	July 10	25.0	59.0	Medium
Mediterranean .	....	Fair .	Slightly	Some...	Medium	Little...	June 4	July 9	24.0	.....	Soft, good
Kharkof.....	4	Good	Killed in spots	Very badly .	Bad.....	Con-sid'rble	June 8	July 10	23.5	59.5	Very good
Currell	5	Fair .	Slightly	None...	Medium	"	June 4	July 9	23.1	.....	Soft, good
Padi	4	Good	None	Little...	"	Some ...	June 12	July 14	21.0	58.0	Off-color, poor
Yaroslav [3].....	5	"	"	Badly ..	Severe..	Considerable.	June 10	July 14	16.3	58.0	Medium

[1] From central Crimea. [2] From northern Crimea. [3] Yaroslav from Yaroslav, Russia.

The season of 1902–1903 was one of unusually heavy rainfall with very little drying weather before harvest. As a result, all the wheats ripened from one to two weeks later than was usual for this region.

Turkish Red again led the list in yield, but was very closely followed by the Hungarian varieties.

Weissenburg gave the best quality in the test, with Turkish Red second.

All the varieties except the Russian were injured by the winter, and the Russian varieties were not all equally hardy. Kharkof, Girka and Ulta were injured in spots.

Turkish Red and the Hungarian wheats lodged very little, while of the Russian wheats, Girka, Kharkof and Yaroslav lodged so severely that they could scarcely be cut.

The Russian wheats also rusted much worse than the native varieties or the Hungarian.

In 1904 some of the wheats were severely injured by a fungus disease new to this region. This disease, *Fusarium culmorum,* commonly called "scab" or "blight," attacks the head, growing upon the glumes and young kernels. When the disease is slight, the kernels are wrinkled and shriveled; when very severe, the berry is turned white and is given a moldy appearance. Grain thus affected is very light in weight, unmarketable and possesses no value as a food. Turkish Red and the Hungarian varieties were unaffected by the disease this season. Big Frame was very severely attacked, about seventy-five per cent of the heads being affected. The Russian varieties, Kharkof, Padi and Yaroslav, also suffered considerable injury.

The varieties injured yielded considerably less, were lighter in weight and very much poorer in quality.

The promising varieties were seeded the next fall with Nebraska-grown seed as heretofore.

TABLE III.—*Variety test, 1904.*

Variety.	Years grown in Nebraska.	Stand.	Winter-killed.	Lodged.	Rust.	Scab.	Date headed.	Date ripe.	Yield per acre.	Weight per bu.	Quality.
				Per ct.	*Per ct.*	*Per ct.*					
Turkish Red.....	8	Good	None ...	30	50	15	June 4.....	July 13	17.8	54.0	Fair
Big Frame.....	8	"	" ...	20	95	65	June 3.....	July 12	17.5	46.5	Poor
Winter Fife.....	5	"	" ...	80	85	55	June 4.....	July 13	12.0	47.0	Very poor
Crimean [1].....	5	"	" ...	15	50	95	June 4.....	July 13	11.8	26.5	Very poor
Crimean [2].....	5	"	" ...	15	40	60	June 4.....	July 13	11.0	40.0	Medium poor
Ulta.....	5	"	" ...	10	60	85	June 4.....	July 13	9.8	34.5	Very poor
Malakoff	2	"	" ...	40	80	75	June 4.....	July 13	9.0	41.0	Very poor
Beloglina.....	5	"	" ...	40	60	90	June 4.....	July 13	8.3	29.5	Extremely poor
Weissenburg.....	5	"	Slightly.	10	70	97	June 4.....	July 13	8.0	32.0	Very poor
Pester Boden	5	"	None ...	15	80	95	June 4.....	July 13	7.3	26.5	Extremely poor
Kharkof.....	5	"	" ...	75	90	70	June 4.....	July 13	6.8	38.5	Very poor
Theiss.....	5	"	" ...	15	85	98	June 4.....	July 13	6.8	29.0	Extremely poor
Banat	5	"	" ...	15	85	99	June 4.....	July 13	6.3	28.0	Extremely poor
Yaroslav [3]	6	"	" ...	5	50	99	June 8.....	July 13	4.3	23.5	No good
Girka	5	"	" ...	80	85	.....	June 4.....	July 13	.....	....	Scab made too poor to thrash
Padi	5	"	" ...	30	40	.....	June 4.....	July 13	.....	....	

[1] From central Crimea. [2] From northern Crimea. [3] Yaroslav from Yaroslav, Russia.

The season of 1903–1904, owing to the ravages of the Hessian Fly and the two diseases, rust and scab, was very unfavorable to wheat. The Station harvested the lowest yields and poorest quality of grain since the beginning of experiments with wheat. All the varieties passed through the winter without injury, except Weissenburg, a Hungarian sort, and started growth vigorously in the spring. This, like 1902-1903, was a very "wet" year. As a result, all the varieties made a rank growth of straw and all lodged badly.

Yaroslav from Yaroslav lodged the least and yielded least. Turkish Red headed the list both in yield and quality. Big Frame was a close second in yield but was very much poorer in quality. Turkish Red weighed fifty-four pounds per measured bushel and contained only fifteen per cent of scabby berries. It was the only variety good enough to sell on the Lincoln market.

The column headed "scab" in the table shows the per cents of scabby berries in the grain when thrashed. These, leaving out Turkish Red with fifteen per cent scabby berries, vary from fifty-five to ninety-nine. Scab is a wet weather disease, consequently little trouble is expected from it in ordinary seasons except possibly in a few of the Missouri River counties.

Turkish Red has shown itself able to withstand the attacks of the disease better than any other variety tested. Since it also yields better, it is recommended for planting as the most desirable sort for all but the most northern counties of Nebraska.

The Crimean, which has given very good returns throughout the tests, is considered to be from the same original source as Turkish Red. The chief difference between the two seems to be a difference in the length of time they have been raised in this region, Turkish Red having been grown in this climate much longer.

The Hungarian varieties, Banat, Weissenburg, Pester Boden and Theiss, give considerable promise. They yield fairly

well and may do better when grown here for a sufficient length of time. The quality of the grain both from the dealers' and millers' standpoint is extra good. The weak points of these varieties are medium yield, late maturity and medium hardiness. Some of these objections may be overcome by growing the wheats here for a longer period. As evidence of this it may be pointed out that these wheats, as compared with Turkish Red grown under the same conditions, mature about a week earlier than when first imported from Europe.

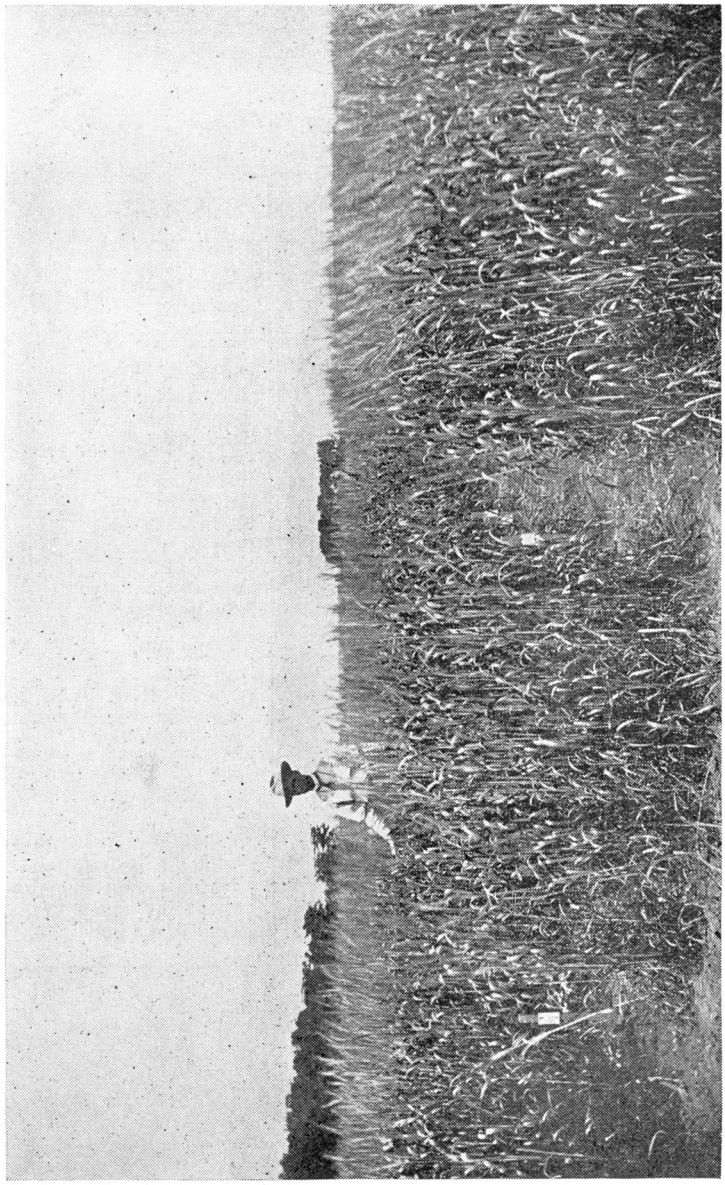
The so-called Russian varieties, Ulta, Beloglina, Kharkof, Yaroslav from Yaroslav, Girka and Padi, while extremely hardy are mostly light yielders and very late in maturing, so that the quality of the grain is seldom above medium.

Kharkof and Beloglina have given the most promise. These wheats, on account of their extreme hardiness, are recommended for extreme northern Nebraska.

It is interesting to note that no variety has given such good results as our own Turkish Red. Crimean, acknowledged to be of the same origin, does not equal it. Kansas and western Kansas Turkish Red seed usually mature earlier and produce a slightly superior quality of grain; but such seed is more subject to disease, does not stand the winters as well and does not yield as well.

COOPERATIVE TESTS OF KHARKOF AND BELOGLINA WHEATS.

In 1902 and 1903 the U. S. Department of Agriculture in cooperation with the Station sent out seed of two Russian varieties of winter wheat (Kharkof and Beloglina). This seed was distributed among farmers located in the northern and northwestern portion of the winter wheat growing region, one bushel of seed being sent to each experimenter. No attempt was made to control the method of preparing the land or to regulate the seeding. It was intended that these wheats receive the same treatment as other wheats grown by these parties. The individual results are given in detail in Table IV.



Wheat breeding plats. Each plat is from the seed of an individual plant selected for high yield and superior quality. Seeds are planted six inches apart each way.

TABLE IV.— *Cooperative tests of Kharkof and Beloglina wheats.*
KHARKOF, 1903.

	ANTELOPE COUNTY.
Experimenter	D. M. Decamp
Post-office	Clearwater
Sown on upland or bottom?	Upland
Depth to water?	25–30 feet
Nature of soil, i. e., gumbo, loam, sandy loam or sand?	Sandy loam
Nature of subsoil?	Sand
Method of preparing soil for crop?	Double disked
Depth of plowing (if plowed)?	
Date of sowing?	Oct. 1
Amount of seed per acre?	1½ bushels
Good or poor stand in the fall?	Poor
Protection by windbreak or snow?	None
Condition in spring?	Poor
Date of ripening?	July 15–20
Did it rust, smut or lodge?	No
Date of cutting?	July 20
Yield of thrashed grain per acre?	12 bushels
Compare with other varieties raised in your vicinity.	Turkish Red sown at same time, same amount seed, stood better, yield 16 bushels.
Remarks	Considering late seeding, kind of soil, fall and spring conditions, pastured by stock, etc., considered good.

TABLE IV.—*Continued.*
KHARKOF, 1903.

ANTELOPE COUNTY.		PIERCE COUNTY.
John E. Cooley.....	Chas. F. Hanford.....	H. G. Hoffart.....
Clearwater.....	Neligh.....	Plainview.....
Upland.....	Upland.....	Upland.....
50–60 feet.....	150 feet.....	75 feet.....
Clay.....	Clay loam.....	Black loam.....
Clay.....	Hard yellow clay.....	Clay.....
Drilled in corn.....	Cultivated in.....	Plowed, press drilled.....
.....	.....	8 inches.....
Sept. 7.....	Sept. 12.....	Sept. 13.....
1½ bushels.....	2 bushels.....	2 bushels.....
Pretty good.....	Fairly good.....	Good.....
Snow nearly all winter..	Snow most of winter...	Partly covered with snow.
Good.....	Poor.....	Fair.....
July 12-18.....	July 12.....	July 15–18.....
Low places lodged.....	No.....	Rusted and lodged a little.
July 20.....	July 12.....	July 18.....
23 bushels.....	11 bushels.....	15 bushels.....
Grew ranker, tillered better than Big Frame or Turkish Red; weaker straw. Outyielded spring wheat 6–14 bushels, winter wheat 7–11 bushels.	Under same conditions a little better than Turkish Red.	On same ground Turkish Red yielded 13 bushels, but better quality.
Think it a fine wheat, vigorous, hardy, superior to Big Frame, withstands wind better.	If wheat had been dril'ed am confident yield would have been doubled.	One kind appeared as hardy as the other.

TABLE IV.—*Continued.*
KHARKOF, 1904.

	BURT COUNTY.	CUMING COUNTY.
Experimenter	Frank A. Gustafson..	Chas. Y. Thompson..
Post-office	Oakland	West Point
Sown on upland or bottom?	Second bottom	Upland
Depth to water?	30 feet	
Nature of soil?	Black loam	Black loam
Method of preparing soil for crop?	Drilled	Plowed early, oat stubble.
Date of sowing?	Sept. 17	Sept. 15
Amount of seed per acre?	5 pecks	1¼ bushels
Good or poor stand in fall?	Good	Good
Protection by windbreak or snow?	No	Oats protected some. Little snow.
Condition in spring?	Good	Good
Date of ripening?	July 12	July 15
Did it rust, smut or lodge?	Badly rusted	Badly rusted, some lodged.
Date of cutting?	July 12	July 15
Yield of thrashed grain per acre?	11 bushels	5 bushels
Compare with other varieties raised in your vicinity	Turkish Red 18–22½ bushels per acre. Turkish Red plumper and more color.	Turkish Red on same field yielded 24 bushels per acre.
Remarks	Turkish Red better for this part of Nebr.	Turkish Red hardly rusted at all.

TABLE IV.—*Continued.*
KHARKOF, 1904.

DAKOTA COUNTY.	WASHINGTON COUNTY.	BUTLER COUNTY.
W. P. Hill	Otto G. Frahm.	Mat Hasik
Randolph	Fort Calhoun	Abie
Second bottom	Upland	Upland
100 feet	25 feet	75 feet
Loam	Black loam (wet)	Loam
Plowed, disked twice	Prepared for sugar beet in spring, millet sowed, wheat drilled into millet stubble	Plowed, harrowed fine
October 21	Sept. 20	Sept. 18
1½ bushels	1¼ bushels	2 bushels
Good	Good	Good
No	Cattle on field in winter	
Good	Good	Excellent
July 10	July 7	Same as Turkish Red
Little rust	Badly rusted and lodged	Rusted some and scab
July 10	July 7	
12½ bushels	Too poor to thrash	9 bushels
Other wheat poor, this good.		All scabby this year
Better if seed had been obtained earlier.	Think ground used was unsuitable.	

TABLE IV.—*Continued.*
KHARKOF, 1904.

	ANTELOPE COUNTY.	
Experimenter	John E. Cooley	Geo. F. Coupland
Post-office	Clearwater	Elgin
Sown on upland or bottom?	Upland	Upland
Depth to water?	30 feet	55 feet
Nature of soil?	Clay	Loam clay subsoil
Method of preparing soil for crop?	Drilled in corn	Plowed, harrowed twice and drilled.
Date of sowing?	Sept. 10	Sept. 20
Amount of seed per acre?	1⅛ bushels	1¼ bushels
Good or poor stand in fall?	Poor	Good
Protection by windbreak or snow?	Cornstalks, snow	Snow cover 6 weeks.
Condition in spring?	Fair	Good
Date of ripening?	July 10–16	July 10
Did it rust, smut or lodge?	Slight rust	Quite a little rust
Date of cutting?	July 16	July 10
Yield of thrashed grain per acre?	11½ bushels	15 bushels
Compare with other varieties raised in your vicinity	Yield better than spring wheat, less than other winter wheat.	Turkish Red yielded 28 bushels. Kharkof ripens earlier and better stand.
Remarks	Ground dry; too little seed; hardy; none winterkilled.	Consider it promising because of hardiness, stiff straw, early ripening. Better yield when acclimated.

TABLE IV.—*Continued.*
KHARKOF, 1904.

ANTELOPE COUNTY.	CEDAR COUNTY.	COLFAX COUNTY.
Wm. Hupp	Earle A. Tolles	F. Rabeler
Vim	Laurel	Leigh
Upland	Bottom land	Upland
35 feet	Creek bank 9 feet up	20 feet
Sandy loam	Loam	Black loam
Drilled in corn	Plowed and harrowed	Plowed, disked twice, and harrowed
Sept. 18	Sept. 15	Sept. 24
1¼ bushels	1¼ bushels	1¼ bushels
Good	Good	Good
Cornstalks	Some snow	None
Poor	Very good	Good
July 11	July 15	July 18
Rusted badly	Rusted badly, some smut.	Rusted badly, some smut.
July 16	July 16	July 18
6½ bushels	5 bushels	4 bushels
Poor	Neighboring crops good	Some varieties as poor. Turkish Red yielded 20–30 bushels per acre.
		Grain poor this season

TABLE IV.—*Continued.*
KHARKOF, 1904.

	KNOX COUNTY.	
Experimenter	Premysl Sedivy	James Beachley
Post-office	Verdigris	Creighton
Sown on upland or bottom?	Upland	Upland
Depth to water?		25 feet
Nature of soil?	Loam	Sandy loam
Method of preparing soil for crop?	Plowed oat stubble	Oat stubble with disk and drilled in corn
Date of sowing?	Sept. 18	Sept. 10
Amount of seed per acre?	1½ bushels	1½ bushels
Good or poor stand in fall?	Good	Fair
Protection by windbreak or snow?	None	None
Condition in spring?	Fair	Poor
Date of ripening?	July 14	July 12
Did it rust, smut or lodge?	Rusted badly	Rusted badly
Date of cutting?	July 14	July 14
Yield of thrashed grain per acre?	12 bushels	20 bushels
Compare with other varieties raised in your vicinity	If had not rusted, judge it better than others.	Other wheat made 8 bushels per acre
Remarks	Sown broadcast because had no press drill.	

TABLE IV.—*Continued.*
KHARKOF, 1904.

PIERCE COUNTY.	FURNAS COUNTY.	HOLT COUNTY.	SHERIDAN COUNTY.
H. G. Hoffart.....	A. S. Wyatt.....	L. S. Herron.....	Wm. Sandoz.....
Plainview.....	Hendley.....	Ewing, R. R. 1...	Moomaw.....
Half and half.....	.....	Upland.....	Upland.....
75 feet.....	120 feet.....	92 feet.....	18 feet.....
Heavy black loam.	Loam.....	Sand.....	Sandy black loam..
Plowing.....	Stalk ground.....	Drilled in corn...	Backset.....
Sept. 21.....	Sept. 15.....	Sept. 13.....	Late fall.....
2 bushels.....	1 bushel.....	1¼ bushels.....	1 bushel.....
Poor.....	Good.....	Good.....	None.....
Very little snow...	Cornstalks.....	Standing corn, little snow.	None.....
Poor.....	Good.....	Winterkilled.....	Fair.....
July 20.....	Did not ripen.....	July 19.....	.....
Rusted badly.....	Black rust.....	Rusted badly.....	Rusted badly.....
July 22.....	.....	July 19.....	Aug. 3.....
11 bushels.....	.....	6 bushels.....	Too poor.....
Yield as good as others but quality very poor.	Rusted more than others.	Same field, other wheat gave 10 bushels of better quality.	Sea Island made 10 bushels and almost no rust.
.....	.....	Wheat slow in starting in the spring.	Wheat sown too late and winter a hard one.

TABLE IV.—*Continued.*
BELOGLINA, 1903.

	CUSTER COUNTY.	
Experimenter	Hans G. Arp	Frank Jennings
Post-office	Scandia	Mason City
Sown on upland or bottom?	Upland	Upland
Depth to water?	200 feet	120 feet
Nature of soil, i. e., gumbo, loam, sandy loam, sand?	Sandy loam	Sandy loam
Nature of subsoil?	Clay	Light clay
Method of preparing soil for crop?	Plowing, harrowing. (Put in with press drill.)	Double disked
Depth of plowing (if plowed)?	3 inches	6 inches last spring
Date of sowing?	October 4	October 1
Amount of seed per acre?	1 bushel	1 bushel
Good or poor stand in fall?	Fair	Poor
Protection by windbreak or snow during winter?	None	Partially snow covered
Condition in spring?	Good	Very poor
Date of ripening?	July 8	August 1
Did it rust, smut or lodge?	No	One-half rusted and lodged badly.
Date of cutting?	July 14	
Yield of thrashed grain per acre?	22 bushels	16 bushels
Compare with other varieties raised by you in your vicinity	Other wheat yielded 10-25 bushels per acre	Turkish Red 10-25 bushels per acre.
Remarks	Think it good wheat in dry winters, as it stands frost well. Sowed 10 acres this season.	Think it will prove a good wheat.

TABLE IV.—*Continued.*
BELOGLINA, 1903.

CUSTER COUNTY.		HARLAN COUNTY.
Frank Kulpa Mason City	C. B. Lauridsen Scandia	R. J. Ashby Alma
Upland 100 feet	Upland 200 feet	Upland 100 feet
Light clay with a little sand.	Clay loam	Loam
Yellow clay Drilled between corn rows.	Clay Plowed, harrowed twice.	Magnesia clay Drilled in corn
	5 inches	
October 20 1 bushel Fair	September 20 1 bushel Good	October 1 bushel Extra good
None Fair July 1 No	None Good July 0 A little	Snow Good July 12 A little
July 3 20½ bushels	July 20 22 bushels	July 15 33 bushels
Quality good. Yield averages with other varieties.	Other wheat yielded 25 bushels.	Withstood storms better than Turkish Red, which yielded 25 bushels in same field.
	Think Beloglina good wheat. Sowed all I had again.	Have sown in corn again for next year's crop.

TABLE IV.—*Concluded.*
BELOGLINA, 1904.

	CUSTER COUNTY.
Experimenter	C. B. Lauridsen
Post-office	Scandia
Sown on upland or bottom?	Both
Depth to water?	200 feet
Nature of soil?	Loam and grained clay
Method of preparing soil?	Plowed, harrowed
Date of sowing?	September 20
Amount of seed per acre?	1 bushel
Good or poor stand in the fall?	Good
Protection during winter?	None
Condition in spring?	Good
Date of ripening?	uly 20
Did it rust, smut or lodge?	Rusted and lodged on bottom land
Date of cutting?	July 20
Yield of thrashed grain per acre?	15 bushels
Compare with other varieties raised in your vicinity.	Withstands winter better.
Remarks	

These reports are quite conflicting but bring out one fact, the superior hardiness of these two varieties of wheat. While not equal to Turkish Red in yield, their greater hardiness may make them valuable where the winters are too severe for Turkish Red.

They also give promise of making valuable wheats for the semiarid region. Mr. J. G. Haney, Superintendent Ft. Hays Branch, Kansas Experiment Station, reports the following yields at Ft. Hays, Kansas, in 1903 and 1904:

Variety.	Yield 1903, Bu. per acre.	Yield 1904, Bu. per acre.
Turkish Red	35.62	20.37
Kharkof	40.90	20.41
Beloglina	38.24	19.04
Ulta	36.35	20.50
Crimean	40.61	20.00

NATURE AND CAUSES OF "YELLOW BERRY" IN HARD WINTER WHEAT.

From time to time the Station has received complaints from farmers, grain dealers and millers concerning deterioration in hard winter wheat caused by the appearance of yellow kernels, commonly called "Yellow Berry." It was claimed that the presence of the "Yellow Berry" reduced the yield and quality of flour. Dealers said the wheat was "off color" and consequently must be cut in grade.

Investigation into the cause and seriousness of this trouble was begun in 1902 and has been continued until the present time.

In order to obtain definitely the consensus of opinion concerning "Yellow Berry" among dealers and millers, a circular letter and list of questions was sent out to the grain dealers and millers of the state. The questions and answers were as follows:

Question 1. What is "Yellow Berry"?

Answers: "Yellow kernels in hard winter wheat"; "Hard winter wheat perfectly developed"; "Yellow kernels"; "Russian wheat or deteriorated Turkish"; "Degenerated Turkish Red wheat"; "Degenerated wheat"; "Overripe, run down seed"; "One-half to two-thirds yellow in color"; "Degenerated variety"; "Wheat that produces a yellow flour"; "Yellow shading in the berry"; "A berry with nothing in it."

A few dealers in Butler, Fillmore, Nuckolls, Saunders and Seward counties reported that they had either never heard of "Yellow Berry" or that the wheat grown in their territory was as yet unaffected by it.

Question 2. What causes it?

Answers: "Climatic conditions"; "Perfect conditions"; "Soil or climate affecting the gluten in wheat"; "Soil and climate"; "Do not know"; "Deterioration"; "Time of cutting"; "Too long standing"; "Condition and quality of the gluten"; "No one knows"; "June rains and Hessian Fly"; "Becoming overripe or sun-bleached"; "Sowing same seed year after year"; "Too rapid growing."

Question 3. Can it be prevented?

Answers: "Do not know"; "Think so"; "To a great extent"; "Yes"; "No"; "By cutting early and stacking immediately"; "Do not think so."

Question 4. If it can be prevented, how?

Answers: "Cut when green"; "Do not know"; "By a change of seed"; "By care of the seed"; "By cutting at proper time to harvest."

Question 5. What effect does it have on market value?

Answers: "Sells for from two to three cents less than hard winter"; "Discounted one to three cents"; "Sometimes discounted"; "Reduces the value one to three cents per bushel"; "Worth three cents less per bushel than red winter"; "Causes a reduction of from two to four cents"; "Sells lower than good colored wheat"; "Variable"; "From one to three cents lower than Turkish"; "Some years twenty cents per bushel discount"; "Two cents discount"; "Some mills refuse it and others make no difference"; "Lessens the value"; "Has the same effect as blight."

Question 6. What effect does it have on the flour-making quality of a wheat?

Answers: "It gives the flour a yellowish cast"; "Gives a good yield of flour but lacks strength"; "Lacks strength and color"; "The bran is thicker and the flour yellow"; "Do not know"; "The flour lacks gluten"; "A bugaboo"; "Reduces the test"; "Injurious to the baking quality"; "Makes black flour."

Question 7. What effect does early or late cutting have on the amount of yellow berry?

Answers: "Early cutting has less"; "Late cutting does not help"; "Do not know"; "No difference"; "Late cutting increases it"; "Early decreases it"; "Early cutting prevents it"; "Late cutting causes it."

Question 8. What effect does exposure to the weather have on yellow berry?

Answers: "The longer it stands the more yellow berry"; "None"; "Increases it by bleaching"; "Bleaches and softens

it"; "The effect varies according to when cut"; "Produces it."

Question 9. Is the amount of yellow berry greatest in wet or dry seasons?

Answers: "The amount is greatest in wet seasons"; "Do not know"; "Dry season"; "No difference"; "Depends on time of cutting any year"; "Most in good crop years."

Three-fifths of the replies to this question said the amount of yellow berry was greatest in wet and two-fifths claimed dry seasons.

Question 10. Does the kind of soil influence the amount of yellow berry?

Answers: "New soil has less"; "No"; "Think so"; "Decidedly"; "Light upland has less"; "Do not know"; "Do not think so"; "Somewhat"; "Yes, rich soil has a great deal more."

Question 11. Please give the approximate percentage damage done by yellow berry in the following seasons for your territory: 1901, 1902, 1903, and 1904.

Answers: "Can not give the data you ask, but think yield enough better to offset any damage from yellow berry"; "In the season of 1901, it was all yellow but quality otherwise good; in 1902, it was all bleached and sprouted; in 1903, sixty per cent yellow; in 1904, sixty per cent yellow"; "1901, little wheat in territory; 1902, good crop, largely yellow; 1903, good crop, less yellow than 1902; 1904, fair crop, but injured by the rust"; "1901, advantageous; 1902, advantageous; 1903, detrimental; 1904, very detrimental"; "Can not call it a damage. Rather say it had never attained the necessary quality"; "1901, Nebraska wheat discounted fifteen to twenty per cent under Kansas; 1902, slight if any; 1903, not noticed; 1904, not noticed"; "We suffered no loss these years as we sold all our yellow berry to mix with soft wheat"; "We heard of no damage in these years"; "1901, ten per cent damage; 1902, twenty per cent damage; 1903, forty per cent; 1904, fifty-five per cent"; "Don't know about 1901, 1902 and 1903, but 1904 had about ten per cent in our region."

Question 12. Give your opinion of the value of a successful, cheap and practical method which would prevent or materially reduce the amount of yellow berry in your territory and in the State.

Answers: "No value if yield were reduced"; "Such a method would improve the flour and wheat business of Nebraska"; "Don't think there is any"; "Hard to estimate in dollars and cents."

Remarks: "Frequently the harder the wheat sown the softer the resulting crop and the more yellow berry"; "We need frequent importations of pure Turkish Red, as Nebraska soil does not hold the original color"; "The imported Turkish Red only retains its own characteristics for about three years. Hard, dark red wheat always produces better flour"; "A frequent change of seed reduces the trouble"; "Giving careful attention to seed, avoiding old and shrunken seed and changing seed every three years, together with a careful study of the best time to cut, would materially reduce the trouble with yellow berry"; "If cut at the proper time and stacked as soon as dry enough, little trouble need be experienced"; "There is more yellow berry in northern Nebraska than in southern Nebraska. It yields better than Turkish Red and mills accept it"; "The only remedy is to raise hard wheat by importing fresh seed from Russia frequently"; "Our mills have turned away yellow wheat and paid a better price for the red."

These replies show that quite a divergence of opinion exists, not only concerning the cause and treatment of yellow berry, but also concerning the importance which it bears to the wheat and milling industries, even among the dealers and millers who handle the crop. A part of this difference of opinion is no doubt due to a difference of location. Dealers and millers in or adjacent to the soft wheat regions would not see the differences found by dealers and millers in the hard wheat region.

In 1903, the Station took up the investigation of this problem along the following lines:

To see if the yellow berries were due to bleaching by sun and weather after harvest, sheaves were taken from the same portion of the same plat, one-half being left exposed and the other half cured in a dry room which was only moderately lighted. These sheaves were cut July 10, 1903. The exposed bundle was left out until August 21, 1903, the only protection given being a frame of wire netting having a mesh small enough to keep out sparrows. In September, the bundles were carefully thrashed and the grain separated into two portions, "Yellow Berry" and "Horny Red," keeping each bundle by itself. The bundle kept in a dry, dark room had twenty-five per cent of yellow berries, while the exposed bundle had ninety-seven and two-tenths per cent yellow berries.

Other noticeable changes took place. The grain from the protected bundle was bright and of good, clear color. The grain from the exposed bundle was very much discolored and so badly bleached as not to be marketable.

In 1904, the experiment was continued along the same lines. The difference in the amount of yellow berry was not nearly as great as in 1903, being seven per cent for the protected and sixteen per cent for the exposed bundle. But while a smaller per cent turned into yellow berry than in 1903, by reason of the exposure, the effect of bleaching and discoloration was about the same.

In order to see if the time of cutting influenced the amount of yellow berry, sheaves were cut at intervals of four days from the soft dough stage until the wheat was thoroughly ripe.

The first cutting was made June 29, 1903, the second July 3, the third July 7, the fourth July 10. The per cent of yellow berries was least for the earliest cutting and most for the latest cutting, being as follows: Cut June 29, seven and six-tenths per cent yellow berries; cut July 3, eighteen per

cent; cut July 7, nineteen per cent, and cut July 10, twenty-five per cent yellow berries.

In 1904, the intermediate cuttings were dropped out and only an early and an overripe cutting made. The early cutting, made July 7, gave seven and six-tenths per cent yellow berries and the overripe cutting made nineteen per cent yellow berries.

Thus it is seen that there is a steady increase in the amount of yellow berry as the grain becomes riper.

The character of the season independent of any method of handling the crop might influence the amount of yellow berry. To determine this, the amounts of yellow berry in the wheat of different years were found. For this purpose grain was used just as it came from the thrashing machine. In the crop of 1901 there was 10.5 per cent; in the 1902 crop, 4.3 per cent; in the 1903 crop, 25 per cent of yellow berries, and the crop of 1904, 20 per cent yellow berries.

In the early spring of 1901 there was a good rainfall, but June was very hot and dry, particularly in the latter part of the month. The season was a favorable one for winter wheat, both as to quantity and quality of grain. The winter and spring of 1902 were extremely dry, and the drought of the previous year had left very little moisture in the soil. About the middle of May abundant rains set in and continued for the remainder of the season. In spite of the late rains the harvest was an early one, the quality of the grain was good, and the yield was considerably less than that of 1901. The seasons in 1903 and 1904 were both cool and wet. Harvest was late, and the yield was good, except in 1904 when a fungus disease destroyed much of the crop, which would otherwise have been large.

There is quite a definite relation between the per cent of yellow berries in the crop and the character of the season in so far as the latter affects the date of ripening, the composition, and the yield of wheat. Table V shows this relation.

TABLE V.—*Relation between per cent of "yellow berry" and character of growing season.*

	1901.	1902.	1903.	1904.
Per cent "yellow berry" in crop.....	10.5	4.3	25.0	20.0
Date of ripening.....	June 24.	June 21.	July 10 .	July 13
Per cent nitrogen in grain.....	2.18	3.19	2.75	2.28
Yield of grain per acre, bushels.....	39.5	30.0	31.1	17.8*

It will be seen from this table that the amount of "yellow berry" increases with the lateness of ripening, and it would further indicate that crops of large yield and low nitrogen content contain more "yellow berries" than do crops of the opposite kind.

Since it has been shown that the amount of yellow berry increases as the ripeness of the grain increases and also with the length of time the cut grain is exposed to the weather, it is possible to lessen the loss by cutting the grain rather early and stacking as soon as sufficiently dry. This method of caring for the crop has the added advantage, if well done, of entirely preventing deterioration by bleaching and discoloring. By stacking, the quality of the grain is kept up and the further advantage is obtained of having the field free from shocks, thus permitting early plowing.

Many of the replies of the dealers and millers to the letter of inquiry stated that the yellow berries were due to a lack of gluten in the wheat. As a basis of comparison, nitrogen determinations were made of all the wheats used in the yellow berry experiment.

The following tables show the results of the analyses of these wheats from the year 1901 to 1904 inclusive. In the tables the horny red and yellow berry of each sample are placed together for handy comparison:

* Low yield due to scab disease.

TABLE VI.—*Composition of horny and yellow kernels in light and heavy seed in different years.*

No.	Description.	Nitrogen.
		Per cent.
40	Horny red (lightest light), 1901	2.23
41	Yellow berry (lightest light), 1901	1.83
42	Horny red (heaviest heavy), 1901	2.32
43	Yellow berry (heaviest heavy), 1901	1.70
44	Horny red (lightest light), 1902	3.20
45	Yellow berry (lightest light), 1902	3.10
46	Horny red (heaviest heavy), 1902	3.40
47	Yellow berry (heaviest heavy), 1902	2.90

TABLE VII.—*Per cent of nitrogen in horny and yellow kernels cut at different times.*

No.	Description.	Nitrogen.
		Per cent.
38	Horny red, cut June 29, 1903	2.35
26	Yellow berry, cut June 29, 1903	1.97
39	Horny red, cut July 3, 1903	2.12
27	Yellow berry, cut July 3, 1903	1.87
28	Horny red, cut July 7, 1903, green sample	1.88
29	Yellow berry, cut July 7, 1903, green sample	1.86
30	Horny red, cut July 7, 1903	2.48
31	Yellow berry, cut July 7, 1903	2.24
35	Horny red, cut July 10, 1903	2.10
36	Yellow berry, cut July 10, 1903	1.97

TABLE VIII.—*Per cent of nitrogen in horny and yellow kernels exposed and protected.*

No.	Description.	Nitrogen.
		Per cent.
32	Horny red, exposed bundle, 1904	2.56
33	Yellow berry, exposed bundle, 1904	2.42
9	Horny red, protected bundle, 1904	2.05
10	Yellow berry, protected bundle, 1904	1.66
18	Horny red, overripe, 1904	2.29
17	Yellow berry, overripe, 1904	1.77
11	Horny red, overripe, exposed bundle, 1904	2.07
12	Yellow berry, overripe, exposed bundle, 1904	1.88

TABLE IX.—*Effect of removing heads from straw.*

Description.	Nitrogen.
	Per cent.
Early cutting, heads removed from straw, kept in dark room.....	1.66
Early cutting, heads removed from straw, exposed.....	1.97
Early cutting, heads on straw, kept in dark room	2.05
Early cutting, heads on straw, exposed.....	2.07

A study of the tables reveals the fact that in every case, without a single exception, the horny kernel has a higher nitrogen content than the yellow kernel from the same sample, which supports the millers' statements that the horny red has more gluten than the yellow berry wheat, and is consequently better for milling purposes.

It has been shown that the amount of yellow berry can be controlled to a large extent by early cutting and stacking; hence the proportion of gluten in any given wheat is controllable within certain limits.

It might be supposed that the occurrence of "yellow berry" is due to the production of starch after the grain is cut. Indeed the experiments of some investigators seem to bear out this opinion. Deherain and Dupont[1] state "that the upper portion of the stem, provided it is still green, performs the functions of the leaves in other plants and thus elaborates starch for the wheat kernel." To show this they removed a number of heads from plants. The next day the stems were harvested as were an equal number of entire plants. The stems without heads showed that carbohydrates equal to 5.94 per cent of the dry matter had been formed. The stems on which the heads remained one day longer showed only 1.63 per cent carbohydrates, the difference representing the carbohydrates elaborated in the stems and deposited in the kernels during that time.

[1] Abs. in Experiment Station Record, vol. 14, p. 654, of the Ann. Agron. 1902, No. 10, p. 522.

The fact that in our own experiments the exposed bundles gave wheat of a lower gluten content seemed to point to the elaboration of starch after cutting as one of the causes of "yellow berry." Other experiments, however, do not corroborate this conclusion.

In those cases where there was sufficient grain after the chemical sample had been removed, the kernels were counted and weighed and the average weight per kernel computed. The horny red kernels were heavier in every case, the difference being approximately proportional to the weights of the kernels. This would make the hypothesis of an after production of starch untenable. Experiments now being carried on may throw some light on this doubtful point.

TABLE X.—*Weights of horny red and of yellow kernels.*

No.	Variety.	Date of Cutting.	Description.	Wt. of average kernel.
35	Turkish Red	July 10, 1903	Horny red	.02846
36	" "	July 10, 1903	Yellow berry	.02681
11	" "	July 7, 1904	Horny red, heads on straw, exposed	.02293
12	" "	July 7, 1904	Yellow berry, heads on straw, exposed	.01866
9	" "	July 7, 1904	Horny red, heads on straw	.02104
10	" "	July 7, 1904	Yellow berry, heads on straw	.01618
4	Theiss	July 2, 1904	Horny red, heads on straw, exposed	.02002
5	"	July 2, 1904	Yellow berry, heads on straw, exposed	.01600

Nowacki suggested as early as 1870[1] that the difference in appearance between mealy and horny wheat kernels is due to the presence in the former of a larger volume of air spaces than in the latter. He argues that the vacuoles that occur in the protoplasm of the cell decrease in size and number as the endosperm develops, and that the more protoplasm the smaller and fewer the vacuoles.

Hackel says:[2] "If the albumenoids so fill up the intervals between the starch grains that the latter seem to be imbedded

[1] Untersuchungen über das Reifen des Getreides, Halle, 1870, pp. 76–77.

[2] The True Grasses, E. Hackel (Trans. Scribner & Southworth), p. 26.

in cement, the albumen appears translucent and the fruit is called corneous; but if the union is less intimate, there remain numerous small air cavities and the albumen is opaque and the fruit is mealy. Both conditions may occur in the same variety (wheat) and they seem to be occasioned by differences in climate and soil."

These explanations account for the lighter weight of the yellow berry kernels. They may also explain why the number of yellow berries increases when freshly cut or ripe standing grain is exposed to the sun. The drying out of the grain, and consequent contraction of the protoplasm, reduces the pressure on the vacuoles, and results in a larger volume of air spaces in the endosperm.

The yellow kernels were found to contain more moisture than the horny ones in grain that had been standing for several months. Table XI shows the moisture determinations in several samples:

TABLE XI.—*Moisture content of horny and yellow kernels.*

Sample.	Per cent moisture in horny kernels.	Per cent moisture in yellow kernels.
Theiss	7.05	7.41
Turkish Red	6.62	7.31
" "	6.63	7.12
" "	6.21	6.40

This would tend to confirm the theory of a more condensed accumulation of proteids in the horny kernels.

E. Fleurent[1] stated, in 1898, that the quantity of gluten in the wheat kernel increased from the center of the grain to the periphery.

N. A. Cobb,[2] working in Australia, (1904) demonstrated the truth of Fleurent's statement. He showed that if the endosperm were removed in arbitrary concentric zones, the

[1] Abstract E. S. R. 10, p. 779 (Comp. Rend. 126 (1898), No. 22, p. 1592.)
[2] Agr. Gaz. N. S. W., vol. XV, part 2, pp. 170–173.

innermost portion contained least gluten, and that the gluten content increased from center to periphery.

Cobb[1] explains the fact as follows: "A comparison of various flour-cells in a given grain shows a number of interesting points. In the first place, it can hardly fail to strike the observer that the outer flour-cells are smaller, and that they contain smaller starch granules. This feature is common to all varieties of wheat, and is in accord with the increasing amount of gluten found in the flour derived from those portions of the grain nearer the outside. It is noticeable that when the grain is rich in nitrogenous matter the number of large starch granules is smaller.

"As we pass, in such grains, in our examination from the center to the outside, we note a gradual decrease in the size of the starch granules, and even at some little distance from the aleuron layer the cells are filled with small granules only."

The work of N. A. Cobb is confirmed by our own experiments. An examination made by Mr. Keyser showed that a typical mealy wheat like the soft, white Sonora of California contained starch granules measuring from 0.02817 millimeters in diameter for the larger, to 0.005634 millimeters across for the smaller. A typical horny Turkish Red kernel contained starch grains varying between the extremes of 0.014085 and 0.002817 millimeters in diameter. A typical yellow berry Turkish Red kernel showed larger starch granules, 0.017042 for the larger and 0.003081 millimeters in diameter for the smaller sizes. In the yellow berry grain the large starch granules were very much more numerous next to the outside than was the case with the horny grain. In order to make a more careful investigation, a number of very horny kernels, a number of the most pronouncedly yellow kernels and a number of medium yellow kernels, were selected. Cross sections were then cut from the center of each

[1] Agr. Gaz. N. S. W., vol. XV, part 6, p. 512.

kernel in the three lots, keeping the sections from each lot by themselves. In order to cut sections from the kernels, it was first necessary to soften them for twenty-four hours by placing them between sheets of wet filter paper. [1]The sections were put in a fixing fluid consisting of osmic, acetic and chromic acids (Flemming's Mixture) in solution, to fix the protoplasmic contents of the cells. Fixation was hurried by heating over a water bath to about 80° C. After fixation, the sections were washed in distilled water and again heated over the water bath. This process dissolved a part of the starch granules. For examination, the sections were stained first for an hour with dilute safranin and then dropped into picric acid. This stained the nuclei red and the protoplasmic network yellow. Before examination, very dilute potassium iodid iodin was run under the cover glass, thus staining the starch granules blue. The protoplasmic network of the cells in the sections from the very horny kernels showed only an occasional vacuole. Sections from the markedly yellow kernels showed very much more numerous and larger vacuoles, measuring on the average less than 0.001 millimeter. Medium yellow berry kernels had fewer and smaller vacuoles than the markedly yellow kernels.

It appears that large starch granules and large and numerous vacuoles are associated in yellow kernels, the white appearance of the endosperm being due doubtless to the latter. The difference in structure between the horny and the yellow kernels is also accompanied by a difference in composition, the yellow kernels containing less nitrogen.

The number and size of the vacuoles is doubtless dependent upon the per cent of proteid matter in the endosperm. The conditions that influence this are discussed in pp. 28–35 and 45–50 of this bulletin. It is quite evident that the tendency toward the production of yellow berries through late harvesting or exposure is inversely proportional to the proteid con-

[1]Adapting Cobb's Method. Agr. Gaz. N. S. W., vol. XV, part 4, p. 361.

tent, and that consequently the soil and climatic conditions previous to harvesting also affect the quality of the grain in respect to the number of yellow berries. A soil rich in nitrogen and a hot, dry growing season are, other things being equal, less likely to produce yellow berries even under unfavorable conditions.

"RUNNING OUT" OF SEED WHEAT.

There is quite a prevalent feeling among farmers, grain dealers and millers that a change of seed wheat from time to time is very desirable. The reason urged for this is that the productive power and the quality of the grain deteriorate after it has been raised in a certain locality for a longer or shorter period.

In order to ascertain, if possible, whether a change of seed is really desirable, and if so what are the advantages of such a change, experiments were begun several years ago, and a preliminary report was made in Bulletin 72 of this Station.

It was shown that seed brought from different localities did not do equally well the first year, the home grown seed being in every way superior to seed of the same variety brought from certain other states where different climatic and soil conditions prevailed.

The experiment has been continued along two lines, the seed obtained originally from Kansas and Iowa in 1899, and grown here since, being compared with Nebraska grown seed. The results are shown in Table XII.

In 1902, seed was obtained from western Kansas, central Kansas, Ohio and Iowa, and grown here since in order to compare with Nebraska grown seed. For these experiments Turkish Red was the variety used. The results are shown in Table XIII.

TABLE XII.—*Adaptation. Seed grown here since 1899.*

	Nebraska.			Kansas			Iowa.		
	1902.	1903.	1904.	1902.	1903.	1904.	1902.	1903.	1904.
Winterkilled	None ...	None ...	None ..	None ...	None ...	None ..	None ...	None	None ..
Lodged	" ...	Slightly	25%	" ...	Slightly	15%	Slightly.	Consid'rbly	30%
Rusted	Slightly	"	30%	Slightly	"	30%	"	"	50%
Scab	None ...	"	15%	None ...	"	50%	None ...	Slightly ...	15%
Date of ripening	June 23.	July 9...	July 13.	June 23 .	July 9...	July 13.	June 23 .	July 9.....	July 23
Yield per acre	33.3	32.6	17.8	24.8	31.3	14.7	24.8	31.6	17.8

TABLE XIII.—*Adaptation. Seed obtained from different states in 1902; grown here since.*

	Nebraska.		Central Kansas.		Western Kansas.		Ohio.		Iowa.	
	1903.	1904.	1903.	1904.	1903.	1904.	1903.	1904.	1903.	1904.
Winterkilled	None ...	None ...	None ...	None ...	None ...	None ...	Slightly ...	None ...	Slightly ...	None
Lodged	" ...	25%	" ...	15%	" ...	20%	" ...	25%	None	25%
Rusted	Little...	50%	Little...	40%	Little...	35%	Consid'rbly	30%	Consid'rbly	30%
Scab	" ...	35%	" ...	45%	None ...	60%	Some	35%	Some	55%
Date of ripening.	July 9 ..	July 13 .	July 9 ..	July 13 .	July 9 ..	July 13 .	July 9.....	July 13 .	July 9	July 13
Yield per acre ..	32.6	17.8	29.6	14.2	31.1	15.5	28.1	13.8	27.3	17.5

By 1902 the wheat obtained from Kansas and Iowa in 1899 had changed sufficiently to head out and ripen at the same time as the Nebraska wheat. The only field differences that could be observed were, that the Kansas wheat lodged a little less than the others, while the Nebraska grain was least affected by rust. In point of grain production the Nebraska wheat was in the lead each year until 1904, when the Nebraska and Iowa seed yielded the same.

The weight of grain per bushel averaged greatest for the Nebraska seed. In only one year, 1902, was it lower than the Iowa seed, and never lower than Kansas seed.

In 1904 the wheat from western Kansas and central Kansas seed suffered much more from the fungus disease (scab) than the wheat from Ohio and Iowa. This is possibly due to the fact that scab or blight is a damp climate disease and can not thrive in a dry atmosphere. The Ohio and Iowa seed had been produced where the disease was common. Those plants which were very susceptible succumbed and failed to produce seed. Hence natural selection gave rise to a strain of wheat which could produce seed even where this disease was prevalent.

On the other hand, the Kansas strain, having been grown in a dry climate where the disease could not thrive, had not been subjected to this rather rigorous natural selection and consequently was damaged much more.

The fact that 1903 and 1904 were unusually wet seasons probably accounts for the small differences in growth and time of ripening. The climatic conditions were, in these years, quite similar to those of Iowa and Ohio.

In yield, the Nebraska grown seed maintained the lead. In 1903, western Kansas seed yielded second to Nebraska seed and gave a slightly better quality of grain, although it weighed a little less per bushel. The seed from central Kansas, Ohio and Iowa came next, in the order named.

In 1904, Nebraska seed led with the Iowa seed a close second. The grain from western Kansas, central Kansas and

Ohio seed was of such poor quality, owing to injury from scab, that it was unmarketable.

The season of 1903 was unusually wet, yet the wheat varieties which had been grown on the Station farm for a number of years were only slightly affected by rust and all gave high yields.

In the fall of 1902, the United States Department of Agriculture sent the Station a shipment of six varieties of wheat. They were Theiss (a Hungarian sort), and the Russian varieties Yx, Girka, Red Bearded, Crimean and Alsace. These were planted in the experiment plats in the same way and at the same time as the regular plats.

Theiss, Girka, Red Bearded and Crimean were also growing in the regular plats but from seed which had been grown on the Station for a number of years until it had become fairly well adapted. The varieties in the regular plats were only slightly affected by rust, lodged little, and gave a very high yield. These same varieties, imported from Europe in 1902, rusted and lodged so badly that they had to be harvested by hand. The yield was scarcely more than one third as large as the same varieties in the regular plats.

TABLE XIV.—*Varieties from Russia and Hungary in fall of 1902 (1902–1903).*

Variety.	Fall condition.	Spring condition.	Winter-killed.	Lodged.	Rusted.	Scab.	Date heading.	Date ripe.	Yield per acre.
									Bushels
Yx	Excellent	Excellent	None	Badly	Very badly	Considerable.	June 14	July 10	9.5
Theiss	"	"	"	"	"	"	June 15	July 13	8.7
Girka	"	"	"	Very badly	Extremely	"	June 16	July 13	4.2
Red Bearded	"	"	"	"	Very badly	"	June 15	July 13	4.7
Crimean	"	"	"	"	"	"	June 15	July 13	9.1
Alsace	"	"	"	"	"	"	June 17	July 13	6.2

A few years ago a large amount of seed wheat was imported by millers and grain dealers from the Crimea, the region in Russia from which the Turkish Red wheat probably came originally. No systematic record was kept of the results obtained from this seed in the hands of the farmers among whom it was distributed, as compared with the Turkish Red, which it was felt by many growers had deteriorated and should be replaced by this new seed. It was generally considered, however, that the freshly imported seed gave better crops than the old Turkish Red.

At the time of the importation, this Station obtained a supply of the seed from Mr. M. A. Carleton, Cerealist of the U. S. Department of Agriculture. This was planted beside wheat of the Turkish Red variety that had been raised on the Station farm since 1896. The following yields per acre were obtained:

	Yield per acre, 1902.	Yield per acre, 1903.	Yield per acre, 1904.
Turkish Red	33.27	32.16	17.83
Crimean	29.25	28.50	11.80

It is apparent from these figures that in point of productiveness there was no advantage in importing this wheat if the Turkish Red commonly raised in this region had received as good tillage and had been as carefully selected for seed each year as was done at the Experiment Station. The Crimean seed did not produce any better quality of grain than did the Turkish Red, although it is commonly reported to have done so elsewhere. These experiments show:—

(1) That wheat undergoes changes when it is moved from one climate or soil to another.

(2) That a variety brought from a more humid to a drier climate will not do as well for a number of years as the same variety which has been grown in the dry climate continually.

(3) That wheat from a more humid region will make a ranker growth of straw.

(4) That wheat from a more humid region will at first produce a larger and softer kernel, but will yield less.

(5) That wheat from a drier region, as western Kansas, yields nearly as well, produces a better quality of wheat but is very much more subject to the fungus disease scab (*Fusarium culmorum*). It has previously been shown that wheat from Kansas is more likely to winterkill. Consequently it is best to get seed wheat grown as nearly as possible under the same conditions as those under which it is expected to be planted, although it may be desirable under some conditions to bring seed from west to east in the same latitude. This is being investigated further.

Wheat should yield better the longer it is grown in one locality. If it does not, if it shows signs of "running out," it simply means that proper care has not been taken. All wheat seed should be thoroughly fanned to free it from small, shriveled, light weight kernels and all foreign seeds. Wheat for seed should not be allowed to get wet. It should never be stored in deep bins with the grain for market, where it is liable to become heated, but should be stored in dry, shallow, well ventilated bins. If such care is taken, wheat in this region will not decrease in yield when grown in the same locality, provided proper crop rotations, methods of manuring and tillage are followed to maintain the fertility of the soil.

IMPORTANCE OF GOOD TILLAGE.

The yield of Turkish Red wheat, the variety most commonly grown in Nebraska, had not fallen below thirty bushels per acre on the Station farm for some years prior to 1904, and this has been exceeded by some good farmers, while the average yield per acre in the county was greatest at twenty bushels per acre in 1903.

In order to show that this low yield was due to improper soil treatment rather than to poor seed, a comparison was made of the average yield of Turkish Red wheat in the State of Nebraska and in Lancaster County with the poorest seed obtainable on the Station farm under the best soil treatment. This comparison is shown by Table XV which gives the results for these years in tabulated form.

TABLE XV.—*Yield of poor seed under good culture.*

Variety.	Year.	Yield per acre from poor seed.	Yield per acre from ordinary seed.	Average yield in the county.	Average yield in the state.
Turkish Red.....	1902	24.6	33.2	..	20.8
" "	1903	30	32.6	20	16.6
" "	1904	15.6	17.8	12	13.8

In the table the poorest seed used on the Station is compared in yield with the average of the county and state for 1902, 1903 and 1904. This poor seed was obtained by separating the ordinary seed that came from the thrashing machine by means of an air blast directed upward against the falling grain, (the Wonder Grader being the machine used,) the light grain being blown out and the heavy grain falling to be caught in a box below, thus forming a light portion and a heavy portion, the light portion being again subjected to separation and the light fourth saved for seed, called "lightest light." This treatment has been continued since 1899 and each year the poorest seed was selected from the crop planted with the poorest seed of the previous year. Seed thus prepared contained all the light weight, shriveled and worthless kernels and most of the cracked kernels. Yet this poor seed under the soil treatment given it at the Station gave a higher yield than the average for the county or state. Thus in 1902 this "lightest light" seed gave a yield of 24.6 bushels per acre while the average for the state was only 20.8 bushels per acre. In 1903, the "lightest light" seed gave

a yield of 30 bushels, Lancaster County had an average of 20 bushels, and the state average was 16.6 bushels per acre. In 1904, the "lightest light" seed yielded 15.67 bushels, Lancaster County averaged 12 bushels, and the state averaged 13.8 bushels per acre.

In this state it is a common practice to plow the land rather late, harrow once or twice and then drill in the seed. Soil treated in this manner is plowed too late in the fall to settle and compact, and numerous air spaces are contained in the loose furrow slice. It dries out readily, preventing a healthy, vigorous fall growth.

All the wheat land on the Experiment Station farm was plowed early, packed and harrowed the same half day as plowed. After every heavy rain the surface was stirred with a disk harrow or with a spike tooth harrow. This treatment gave a finely divided seed bed, well compacted and worked together below the surface. When drilled in, the wheat had plenty of moisture to make a strong, vigorous growth. Then, too, the stubble turned under had time to decay, still further enriching the soil. The essentials in good tillage for wheat are:

(1) Rotation of crops including seeding down to grass or alfalfa at intervals of four to eight years.

(2) Application of barnyard manure to the soil for some previous crop, as grass, alfalfa or corn.

(3) Early plowing. If wheat follows oats, plow immediately after taking off the oats, or disk thoroughly, depending upon the character of the soil.

(4) Harrowing immediately after plowing and keeping the soil disked and harrowed so that the surface soil is always loose. The important thing is to have the top soil loose and the lower soil compacted.

(5) Drilling in the seed early in the fall, except when Hessian Fly is to be avoided.

VARIATIONS IN WHEAT FROM DIFFERENT REGIONS AND IN DIFFERENT SEASONS.

The importation of a number of Russian and Hungarian wheats has afforded an opportunity to study the effect of change of climate upon the composition of the grain during the process of adaptation, and to compare this with the variations from year to year in the composition of a variety well adapted to the locality.

The habit of growth common to both the Russian and Hungarian wheats that has interfered most seriously with their maximum production of seed has been late maturity. This prolongs growth until a time when, in ordinary seasons, the soil is so dry and the weather so hot that the kernels do not fill out well. Thus the harvesting stage is reached prematurely. The date of ripening is therefore stated in each table, and it will be noticed that it has a close relation to the composition of the grain.

The wheats tested were as follows: Sandomir, Yaroslav from Yaroslav, and Yaroslav from St. Petersburg, grown in Russia in 1899; Weissenburg, Pester Boden, Banat, and Theiss, grown in Hungary in 1899; Turkish Red, grown in Kansas in 1899, the same variety grown in Iowa in 1896, and another lot of the same variety grown in Iowa in 1899; Big Frame grown in Kansas in 1896. All of these have been raised on the Station farm each year since their importation.

These wheats have been grown on the same soil year after year, the seasons being the only variable factors. Hence any difference in composition from year to year may be attributed to the effect of the season, and change of habitat.

Analyses were made of the wheats in most cases when received and of nearly all the crops since. These results are shown in Table XVI arranged by varieties.

TABLE XVI.—*Variations in growth and composition of wheat from year to year.*

Variety.	Total nitrogen.	Ether extract or fat.	Carbohydrates.	Date of ripening.	Yield per acre.	Nitrogen per acre.	Weight per bushel.
	Per cent.	*Per cent.*	*Per cent.*		*Bushels.*	*Pounds.*	*Pounds.*
Sandomir, grown in Russia, 1899	2.13	1.86	83.96	.....	.....	.....	.....
" and in Nebraska, 1900	2.25	2.15	82.99	July 2	18.3	24.70	54.5
" " " " 1901	3.08	2.79	77.21	July 1	16.5	30.49	50.5
" " " " 1902	3.66	2.14	74.62	June 25	.....	.....	.....
Yaroslav, from Yaroslav, grown in Russia, 1899	1.99	1.96	84.99	.....	.....	.....	.....
" " " and " Nebraska, 1900	3 19	2.07	77.39	July 2	22.0	42.11	60.0
" " " " " " 1901	2.47	2.50	81.37	July 1	29.9	44.31	53.0
" " " " " " 1902	3.33	2.42	76.36	June 25	.....	.....	.....
" " " " " " 1903	2.74	.....	.....	July 14	16.3	26.80	59.0
" " " " " " 1904	4.38	2.03	65.35	July 13	4.3	11.38	23.5
" " St. Petersburg, grown in Russia, 1899	2.03	1.86	84.79	.....	.....	.....	.....
" " " and in Nebraska, 1900	2.85	2.29	79.21	July 2	25.8	44.12	59.5
" " " " " " 1901	2.20	2.29	83.18	July 1	22.7	29.96	50.0
" " " " " " 1902	3.24	2.27	76.27	June 25	.....	.....	.....
Weissenburg, grown in Hungary, 1899	1.98	2.22	84.48	.....	.....	.....	.....
" and in Nebraska, 1901	3.43	2.25	75.02	June 27	.....	.....	.....
" " " " 1902	3.60	2.53	74.61	June 24	26.7	57.78	59.5
" " " " 1903	2.50	.....	.....	July 10	31.5	47.27	61.0
" " " " 1904	2.35	2.37	77.52	July 13	8.0	11.28	32.0
Pester Boden, grown in Hungary, 1899	2.19	2.01	83.51	.....	.....	.....	.....
" " and in Nebraska, 1901	3.59	2.16	75.13	June 27	.....	.....	.....
" " " " " 1902	3.29	2.23	76.94	June 24	24.6	48.56	52.5
" " " " " 1903	2.51	No analysis		July 10	30.5	45.93	61.0
" " " " " 1904	2.35	2.06	78.57	July 13	7.3	10.34	26.5
Banat, grown in Hungary, 1899	2.28	2.15	83.04	.....	.....	.....	.....
" and in Nebraska, 1901	3.75	2.31	74.06	June 27	.....	.....	.....
" " " " 1902	3.33	2.72	76.28	June 24	.....	.....	.....

Banat, grown in Nebraska, 1903	2.61	No analysis		July 10	33.6	52.70	61.5
" " " " 1904	2.25	2.05	78.97	July 13	6.3	8.54	28.0
Theiss, grown in Hungary, 1899	2.48	2.15	81.84	.....	.....	.....	.....
" and in Nebraska, 1901	3.78	2.40	74.25	June 27	.....	.....	.....
" " " " 1902	3.66	2.41	74.71	June 24	25.0	57 10	59.0
" " " " 1903	2.75	No analysis		July 10	30.0	49.50	61.0
" " " " 1904	2.33	1.88	78.67	July 13	6.8	9.55	29.0
Turkish Red, grown in Kansas, 1899	2.90	2.34	79.01	.....	.....	.....	.....
" " and in Nebraska, 1900	2.60	2.28	80.87	June 25	29.1	45.40	.....
" " " " " 1901	2.55	2.09	81.47	June 24	29.3	44 83	.....
" " " " " 1902	3.52	2.20	75.67	June 23	24.8	52 38	.....
" " " " " 1903	2.98	No analysis		July 9	31.0	55.49	59.5
" " " " " 1904	2.40	.....	.....	July 13	14.6	21.12	42.0
Turkish Red, grown in Iowa, 1899	2.76	2.54	79.64	.....	.....	.....	.....
" " and in Nebraska, 1900	No sample analyzed			July 2	22.6	.....	59.9
" " " " " 1901	3 24	2.27	77.13	June 27	31 3	60 85	.....
" " " " " 1902	3.52	2.52	75.41	June 23	24 8	52.38	59 5
" " " " " 1903	2.40	No analysis		July 9	26.8	38.66	59.0
" " " " " 1904	2.27	2.11	78.61	July 13	17.8	40.47	54.0
" " grown in Iowa, 1896	But not analyzed			.....	.....	.....	.....
" " and in Nebraska, 1897	2.51	.....	.....	.....	.....	.....	.....
" " " " " 1898	3.18	.....	.....	.....	.....	.....	.....
" " " " " 1899	No sample analyzed			.....	.....	.....	.....
" " " " " 1900	3.10	.....	.....	June 27	33.0	61 38	.....
" " " " " 1901	2.18	.....	.....	June 24	39 5	51.67	.....
" " " " " 1902	3.19	.....	.....	June 21	30.0	57.42	58.0
" " " " " 1903	2.75	No analysis		July 10	31.0	51.26	60.5
" " " " " 1904	2.28	2.10	78.57	July 13	17.8	24 39	54.0
Big Frame, grown in Kansas, 1896, and in Nebraska ever since.							
" " grown in Nebraska, 1899	2.32	.....	.....	.....	.....	.....	.....
" " " " " 1900	3.01	.....	.....	June 26	34.0	61.40	.....
" " " " " 1901	2.86	.....	.....	June 20	34.0	58.35	.....
" " " " " 1902	.....	.....	.....	June 21	10 8	.....	52.1
" " " " " 1903	2.08	.....	.....	July 8	27.3	34.07	58.5
" " " " " 1904	1.83	3.12	79.91	July 12	17.5	19.21	46.5

The table shows the variation in three chemical constituents and in the date of ripening.

The Sandomir variety when imported from Russia in 1899 had a total nitrogen content of 2.13 per cent. In 1900, the first Nebraska crop had 2.25 per cent total nitrogen, the 1901 crop 3.08 and the 1902 crop 3.66 per cent total nitrogen. In this variety there was a constant increase each year grown here.

The Russian seed of Yaroslav from Yaroslav had a total nitrogen content of 1.99 per cent. In 1900, the Nebraska crop yielded 3.19 per cent of total nitrogen; in 1901, 2.47; in 1902, 3.33; in 1903, 2.74, and in 1904, 4.38 per cent.

The Hungarian Weissenburg seed gave 1.98; the 1901 Nebraska crop, 3.43; the 1902 crop, 3.60; 1903, 2.50; and 1904, 2.35 per cent total nitrogen.

Leaving out Sandomir, which constantly increased in nitrogen content, and Yaroslav, which had an unusually high percentage of nitrogen in 1904 (due probably to immaturity caused by rust and scab), it will be seen that all the varieties have a higher percentage of nitrogen in certain years. For instance, in 1902, all the varieties have a relatively high nitrogen content, while in 1903 and 1904, all the varieties have quite uniformly lower nitrogen contents.

It seems reasonable to conclude that the difference in composition is a seasonal difference, in other words, a difference caused by a change in the character of the season.

Careful comparison will show that the years of high nitrogen content were what would be termed dry years as far as the rainfall during the growing period for wheat was concerned, and that the wet years were low nitrogen years. Further, a study of the carbohydrate production reveals a high percentage in low nitrogen years and a low percentage in high nitrogen years. That is, the high percentage of nitrogen occurring in dry years is at the expense of the carbohydrates. It will also be noticed that in years in which the nitrogen content was high, the date of ripening was early.

The wheats imported from Russia and Hungary contained a higher nitrogen content when raised here than did the original seed, except in 1904 when some varieties were lower in nitrogen than was the imported grain. The process of adaptation affected the composition, largely by increasing the nitrogen content through a failure to completely mature, but when in the cold, wet season of 1904 ripening was delayed until the middle of July, the nitrogen content sank to that of the original grain.

While the nitrogen content of any variety of wheat varies from year to year largely according to the degree of maturation of the crop, there are differences in the composition of different varieties in the same year, when they have apparently reached the same stage of maturation. In other words, the nitrogen content is a variety characteristic. Turkish Red and Big Frame wheats are examples of this.

Glancing at the column showing the total production of nitrogen per acre in the grain, which is obtained by multiplying the yield of grain per acre by the per cent of nitrogen, it will be seen that none of the imported wheats yielded as much per acre as did the adapted varieties, Turkish Red and Big Frame.

It will further be noticed that with these two varieties there is, in general, a larger percentage of nitrogen in the years of small yields, and vice versa. This might lead to the conclusion that high nitrogen content is the result of incomplete maturation, but the difference between varieties shows that it is not always so. Big Frame wheat is ready to cut earlier than Turkish Red, but has a lower nitrogen content. While incomplete maturation is sometimes responsible for high nitrogen content there are other determining factors.

It is somewhat surprising to find that the total production of nitrogen per acre is greater in years of light yield and high nitrogen content than in years of the opposite character, except when light yield is due to causes other than climatic. The hot, dry seasons that characterize the years of high nitro-

gen content and light yield apparently favor a large accumulation of nitrogen by the crop. This may be due to increased nitrification in the soil under such conditions, or to the fact that the nitrates are not washed down where the roots can not reach them, but on the contrary, are concentrated in the surface soil by the upward movement and evaporation of moisture.

The conditions that influence the percentage of nitrogen that the wheat kernels contain appear to be:

(1) The natural tendency of the plant or of the variety.

(2) The amount of readily available nitrogen in the soil, especially during the period of growth previous to heading.

(3) The temperature and humidity, especially during the period of growth after heading.

SUMMARY.

The variety best adapted to Nebraska as a whole is Turkish Red. In the extreme northern part of the state Kharkof has proved hardier.

Several Hungarian varieties are of somewhat better quality than Turkish Red, but are later maturing, and in consequence do not yield as well. They have become more early maturing since being raised here, and promise to be of value.

The very hardy Russian wheats are too late maturing, but are likewise becoming earlier.

"Yellow berry" in hard winter wheat causes an annual loss to the wheat raisers of Nebraska of from one half to one million dollars. The chief cause of this condition is allowing wheat to become overripe, and failure to stack the sheaves.

"Yellow berries" as compared with hard, red ones have a lower gluten content, and are lighter in weight.

Seed wheat brought from a distance did not in any case prove as good as the locally grown seed of the same variety. Locally grown Turkish Red yielded better than imported Crimean for each of the three years tested.

Very poor seed wheat was obtained by fanning out the lightest fourth of the crop for four successive years. This seed, on well tilled land, yielded several bushels more per acre than the average of the county or state for each of three successive years. This was accomplished by rotation of crops, including grass or alfalfa; the use of barnyard manure, and good tillage, all of which shows the importance of such treatment in wheat culture.

Turkish Red seed brought from western Kansas yielded nearly as well as the Nebraska grown seed and was of better quality during the drier years, but suffered more from scab or blight in 1903 and 1904.

The production of nitrogen per acre in the grain is greater in years of light yield and high percentage of nitrogen than in years of large yield, except when the crop is injured by insects or disease.

The fertility of the soil affects not only the amount of the wheat crop, but its quality as well.

ACKNOWLEDGMENT.

All of the chemical analyses entailed by these investigations were made under the supervision of Professor Samuel Avery.

AVAILABLE BULLETINS.

The following bulletins of the Station may be had on request:

No. 25, Detasseling Corn.
No. 27, Experiments in the Culture of the Sugar Beet in Nebraska.
No. 29, Cost of Farm Crops.
No. 30, The Influence of Changes of Food and Temperature on the Quantity and Quality of the Milk of Dairy Cows.
No. 33, Meteorological Observations for 1893.
No. 36, Experiments in the Culture of the Sugar Beet in Nebraska.
No. 38, Nebraska and the Beet Sugar Industry. Report of Dr. Max Hollrung, Halle, Germany. Translated from "Zeitschrift des Vereins fuer Ruebenzucker Industrie des Deutschen Reichs."
No. 40, A Preliminary List of the Honey-Producing Plants of Nebraska.
No. 44, Experiments in the Culture of the Sugar Beet in Nebraska.
No. 45, The Rainfall of Nebraska.
No. 48, Windbreaks.
No. 49, Suggestions for Chicory Culture.
No. 50, Notes on Pruning.
No. 51, Observations on the Codling-Moth.
No. 52, Cornstalk Disease.
No. 53, A Preliminary Report on Experiments with Forage Crops.
No. 54, The Effect of Certain Methods of Soil Treatment Upon the Corn Crop.
No. 55, Ornamental Planting.
No. 56, Methods of Tree Planting.
No. 58, Annual Forage Crops for Summer Pasture.
No. 60, Experiments in the Culture of the Sugar Beet in Nebraska.
No. 68, Feeding Skim-Milk to Calves.
No. 70, Locusts or Grasshoppers.
No. 72, The Adaptation and Improvement of Winter Wheat.
No. 73, Experiments in the Culture of the Sugar Beet in Nebraska.
No. 76, Experiments with Dairy Herd.
No. 77, Poisoning of Cattle by Common Sorghum and Kafir Corn.
No. 78, Macaroni Wheats.
No. 79, Experiments in Orchard Culture.
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No. 84, Pasture, Meadow, and Forage Crops.
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No. 86, Destroying Prairie Dogs.
No. 87, A Test of Calf Rations. Methods of Controlling Contamination of Milk During Milking.
No. 88, Apple Scab and Cedar Rust.
No. 89, Winter Wheat.
Press Bulletin No. 19, The Hessian Fly.
Press Bulletin No. 20, Fattening Pigs and Wintering Brood Sows on Alfalfa and a Grain Ration.

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