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Research in Crops and Soils: A Progress Report

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Research in CROPS and SOILS

A PROGRESS
REPORT

AGRONOMY DEPARTMENT
AGRICULTURAL EXPERIMENT STATION
SOUTH DAKOTA STATE COLLEGE ✣ BROOKINGS

Contents

Explanation of Term

Least significant difference. The minimum amount by which two varieties must differ in yield in order for that difference to be considered statistically significant.

Research in Crops and Soils

A PROGRESS REPORT

By W. W. Worzella, L. F. Puhr, C. J. Franzke, D. B. Shank, V. A. Dirks, J. G. Ross, M. W. Adams, D. D. Harpstead, and A. N. Hume[1]

The Experiment Station Agronomy Farm, located 1 mile east of Brookings, is representative of a large area of land in eastern South Dakota. It consists of 160 acres, 150 of which are laid out in various soil and crop experiments. The soil, commonly called "loam" and classified as Barnes Loam, is in a good state of fertility.

Results of the experiments on this farm will indicate what may be expected from similar soil management, cropping systems, and crop varieties on the same type of soil and under comparable climatic conditions.

Numerous experiments are in progress on this farm. The information in this circular is a progress report on those experiments for which results can now be evaluated. Further results will be published at intervals as the experiments progress.

Crop Variety Tests

The annual variety tests of small grains, soybeans, corn, and sorghum are rotated on 9 ranges of approximately 4 acres each. Small grain data, except those for yield, are for 1954.

Spring Wheat Variety Tests. The results of spring wheat variety trials are given in Table 1.

Lee has been distinctly superior to the other available bread wheat varieties, probably because of its leaf rust resistance and stem rust tolerance. The next best performer has been Rushmore, which also has some stem rust tolerance. The effects of severe injury by Race 15B of stem rust in 4 of the last 5 years are evident in the reduced yields of the other bread wheats, and especially in the durum wheats. Of these Vernum has the best record.

The new bread wheat variety, Selkirk, has performed very well in the 2 years it has been tested; it is moderately resistant to stem rust, especially early in the season. It is, however, easily injured by scab and hot weather and tends to have low test weights. The new durum variety, Sentry, appears to have only a slight superiority over Vernum at Brookings.

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Table 1. Results of Spring Wheat Variety Tests, 1950-54

	Yield in Bushels Per Acre						1954						1953
							Test Wt.			Stem Rust	Drouth Injury	Scab	Leaf Rust
Variety	1950	1951	1952	1953	1954	Average 1950-54	Lbs. /Bu.	Date Headed	Height Inches	Per-cent	Per-cent	Rat-ing*	Per-cent
Bread Wheat													
Lee	32.8	39.0	20.1	23.1	21.2	27.2	50.2	6-19	32	35	4	8	10
Rushmore	27.7	35.6	18.6	21.1	14.1	23.4	49.8	6-20	36	35	3	7	50
Mida	30.8	35.2	14.4	15.7	9.9	21.2	45.2	6-23	37	60	5	7	50
Cadet	25.4	28.2	15.4	22.3	13.3	20.9	46.0	6-27	38	30	6	6	60
Thatcher	26.9	29.8	17.2	15.7	13.3	20.6	46.0	6-21	33	60	4	8	65
Ceres	26.5	33.2	16.2	12.3	11.0	19.8	44.2	6-22	34	60	5	6	60
Rival	28.1	32.4	15.8	11.8	10.5	19.7	45.2	6-23	37	60	5	6	50
Tri. x That. 630	31.6	40.9	21.8	31.3	31.5	31.4	58.8	6-20	37	8	3	3	10
Selkirk	—	—	—	36.3	30.7	—	53.2	6-22	34	30	4	6	8
Rush x Haynes 1935	—	—	—	—	28.3	—	57.2	6-18	37	25	3	—	—
Durum Wheat													
Vernum	32.4	35.8	12.0	15.6	9.4	21.0	43.8	6-22	40	50	6	10	Tr‡
Mindum	28.9	36.6	7.0	8.2	6.4	17.4	39.8	6-24	41	60	8	9	S§
Nugget	29.3	39.4	3.4	6.5	5.8	16.9	33.8	6-20	37	70	8	10	Tr
Stewart	25.4	33.5	5.2	5.1	6.4	15.1	43.8	6-25	41	50	7	10	Tr
Sentry	—	—	—	18.5	16.6	—	50.2	6-20	36	70	5	10	Tr
L.S.D.†	2.3	3.6	2.1	2.2	1.7	1.1							

*Rating score: 1=good; 10=very poor.
†L. S. D.=least significant difference.
‡Tr=trace.
§S=susceptible.

Barley Variety Tests. The results of the variety tests of barley are reported in Table 2. Feed barley varieties as a group have consistently outyielded the malting types. Velvon 11 and Tregal represent very desirable feed barley types. Lodging has continued to be a problem in the harvesting of Odessa, a malting barley. Despite the rust resistance found in Kindred, the yielding ability of this variety is low.

Table 2. Results of Barley Variety Test, 1950-54

	Yield in Bushels Per Acre						Test Wt.	1953					
Variety	1950	1951	1952	1953	1954	1950-54 Average	1954 Lbs./Bu.	Date Headed	Height Inches	False* Stripe	Scab†	Stem* Rust	Lodging Degree
Odessa‡	56.4	37.9	52.6	30.9	49.3	45.4	46.0	6-25	26	0	6	16	80
Spartan	50.0	45.0	47.7	31.0	46.4	44.0	49.0	6-19	28	Tr§	3	20	40
Wisc. 38	57.1	47.9	50.7	25.8	44.2	45.1	45.0	6-30	27	0	6	25	50
Feebar	55.9	56.7	46.8	25.3	42.0	45.3	43.5	6-20	23	4	2	Tr	20
Plains	45.8	49.2	51.2	26.8	53.7	45.3	47.0	6-18	21	1	6	1	50
Tregal	64.2	50.4	49.8	19.9	38.0	44.5	43.0	6-23	23	33	7	27	15
Mars	46.3	43.7	39.3	23.7	44.4	39.5	47.5	6-20	23	17	5	5	15
Velvon 11	59.1	52.0	52.6	24.0	44.4	46.4	41.5	6-25	25	2	5	20	50
Kindred‡	51.3	44.6	45.6	26.6	45.7	42.8	47.0	6-21	25	7	6	2	50
Montcalm‡	50.4	52.5	54.4	27.3	42.2	45.3	42.5	6-25	29	Tr	6	30	25
Manchuria	52.5	46.7	53.5	38.8	53.1	48.9	44.5	6-25	25	7	5	15	80
Custer	—	—	—	22.6	57.1	—	44.0	6-18	23	0	8	20	30
S.D. 414	—	—	—	27.1	57.6	—	47.0	6-20	21	0	5	Tr	20
S.D. 1761	—	—	—	35.8	59.8	—	48.0	6-21	25	0	4	3	30
S.D. 1776	—	—	—	36.8	63.8	—	47.5	6-22	24	0	3	2	17
L.S.D.‖	4.8	4.3	7.2	6.2	6.6								

*Percent.
†1=excellent; 9=very poor.
‡Acceptable malting types.
§Tr=trace.
‖L.S.D.=least significant difference.

Oat Variety Tests. Performance of oat varieties plots at Brookings is summarized in Table 3.

The 5-year, as well as the individual year's data, indicate the superiority of early to mid-early oats carrying resistance to Race 7 of oat stem rust. The prevalance and severity of this disease has reduced yields of varieties susceptible to it. This yield reduction appears to be correlated with maturity, being least in the early variety, Dupree, and greatest in the late variety, Selby.

Table 3. Results of Oats Variety Tests, 1950-54

	Yield in Bushels Per Acre						1954						1953	
Variety	1950	1951	1952	1953	1954	Average 1950-54	Test Wt. Lbs. /Bu.	Date Headed	Height Inches	Stem Rust Percent	Leaf Rust Percent	Heat Damage	Septoria Rating*	Lodging Percent
Richland	79.8	116.4	94.6	78.7	84.0	90.7	32.8	6-21	30	9	35	8	5	60
Vikota	76.8	113.6	89.0	74.4	83.0	87.4	35.0	6-24	32	10	2	8	2	10
Brunker	68.8	100.2	77.0	51.1	78.0	75.0	35.4	6-17	30	30	10	8	10	90
Clinton	73.2	110.8	83.0	61.7	63.1	78.4	33.8	6-22	32	40	28	10	10+	28
Cherokee	69.5	109.2	80.5	59.5	76.6	79.1	37.2	6-19	30	40	25	9	8	15
Nemaha	64.4	109.0	78.0	59.6	77.3	77.7	36.8	6-19	30	32	18	8	8	10
James†	84.8	109.2	89.2	42.5	49.7	75.1	39.7	6-23	33	40	28	10	10+	60
Andrew	79.0	100.5	90.0	73.7	87.9	86.2	36.3	6-19	34	9	28	8	5	10
Shelby	81.3	103.7	75.2	49.6	53.9	72.7	35.3	6-25	36	50	30	10	10+	50
Dupree	79.0	100.2	80.4	52.5	88.6	80.1	36.6	6-19	32	30	15	8	5	30
Marion	—	101.4	90.0	76.6	77.3	—	37.2	6-21	36	15	22	8	4	35
Branch	—	106.4	83.0	76.6	78.7	—	33.9	6-26	37	5	10	10	2	15
Waubay	—	—	80.1	91.5	70.2	—	38.0	6-21	35	22	30	9	6	15
Clintafe	—	—	90.0	53.9	58.5	—	31.8	6-24	35	40	Tr§	8	10	12
Sac. X HJ (CI 5927)	—	—	81.2	78.7	82.2	—	38.7	6-19	33	8	20	9	2	15
Clarion	—	—	80.5	79.4	76.6	—	38.8	6-21	34	15	40	9	7	0
Ajax	—	—	97.8	84.4	82.2	—	32.2	6-25	37	15	22	9	3	45
MO. 0-205	—	—	—	91.5	91.1	—	38.5	6-19	33	15	8	8	3	10
Trojan	—	—	—	65.2	79.4	—	34.9	6-18	30	10	25	6	9	70
Osage	—	—	—	75.2	85.8	—	37.2	6-18	27	5	Tr	7	2	10
Sauk	—	—	—	61.0	85.1	—	35.3	6-24	36	15	20	9	4—	20
Clintland	—	—	—	65.2	61.3	—	36.8	6-21	32	40	Tr	10	8	12
Nemaha (Clint X B-C) (6642)	—	—	—	—	86.9	—	37.6	6-20	32	—	22	15	—	—
Rodney	—	—	—	—	73.0	—	33.4	6-29	38	3	10	9	—	—
Jackson	—	—	—	—	80.8	—	38.8	6-23	35	10	30	9	—	—
L.S.D.‡	6.4	11.4	7.8	12.6	3.0	5.0								

*Rating score: 1=best; 10=poorest.
†Hulless, yield adjusted.
‡L.S.D.=least significant difference.
§Tr=trace.

Flax Variety Tests. Rust and pasmo have been major factors in determining the practical value of flax varieties, as seen in Table 4. The performance of Redwood has been superior to that of any other variety.

Table 4. Results of Flax Variety Tests, 1950-54

Variety	Yield in Bushels Per Acre 1950	1951	1952	1953	1954	1950-54 Average	Test Wt. 1954 Lbs./Bu.	1953 Date of Bloom First	Full	Last	Height Cm.	Rust*	Pasmo* Injury	Lodging Degree
Redwing	18.8	14.6	13.0	21.3	16.4	16.8	54.0	6-19	6-23	7-9	59	2	9	15
Sheyenne	21.3	18.8	25.5	21.6	12.4	19.9	53.0	6-19	6-23	7-10	50	0	4	20
Marine	23.0	26.3	25.9	22.8	11.5	21.9	53.0	6-19	6-23	7-10	57	0	4	10
Koto	20.5	15.8	17.1	21.4	13.6	17.7	53.0	6-20	6-26	7-13	60	6	7	20
Dakota	21.7	21.1	18.6	25.5	13.2	20.0	53.0	6-20	6-27	7-12	59	3	7	40
Bison	18.8	9.7	6.9	14.3	15.0	12.9	53.5	6-22	6-27	7-14	61	6	6	30
Redwood	26.3	23.9	30.9	24.0	12.6	23.4	52.5	6-22	6-26	7-15	58	0	6	30
Royal	25.9	19.2	19.2	24.2	13.4	20.4	53.0	6-19	6-29	7-13	63	3	7	80
B-5128	27.2	21.5	24.5	22.5	14.6	22.1	52.5	6-22	7-1	7-17	66	1	6	10
Crystal	25.1	28.0	24.5	21.1	12.2	22.2	53.0	6-23	6-29	7-13	66	0	4	[illegible]
Rocket	—	26.7	28.6	25.2	11.7	—	51.5	6-20	6-27	7-16	66	0	[illegible]	10
Victor Sel.	—	—	27.6	24.7	14.8	—	52.0	6-22	6-30	7-15	66	0	[illegible]	50
L.S.D.†	1.6	3.4	3.9	3.1	N.S.									

*1 = excellent resistance, 9 = no resistance.
†L. S. D. = least significant difference.

Rye Variety Tests. The four varieties listed in Table 5 have been extremely close in yield. Choice must depend on information from other locations, which indicates that Pierre has the edge in winter-hardiness and is therefore preferable. Since a 1954 crop could not be grown due to fall drought in 1953, the data covers the period 1949-53.

Table 5. Results of Winter Rye Variety Tests, 1949-53

Variety	Yield in Bushels Per Acre 1949	1950	1951	1952	1953	1949-53 Average	1953 Test Wt. Lbs./Bu.	Winter Survival
Dakold	34.6	44.6	35.0	39.9	36.1	38.0	53	100
Pierre	34.3	43.2	40.4	37.5	38.1	38.7	54	100
Emerald	36.2	47.1	31.1	42.3	35.7	38.5	53	100
White Soviet	31.5	48.9	36.1	40.3	33.2	38.0	52	100
L.S.D.*	2.9	4.5	3.0	7.6	2.7	2.0		

*L.S.D. = least significant difference.

Winter Wheat Variety Tests. The results in Table 6 show that Minter and Nebred winter wheats have continued to do well at this station, even when stem rust was a factor in 1953. Winter wheat could not be planted in the fall of 1953 due to the drought. Consequently, the yields given are for the period 1949-53.

Table 6. Results of Winter Wheat Variety Tests, 1949-53

	Yield in Bushels Per Acre						1953			
Variety	1949	1950	1951†	1952	1953	1949-53 Av.	Winter Survival Percent	Test Wt. Lb./Bu.	Date Headed	Stem Rust* Percent
Nebred	31.3	39.3		30.5	29.2	32.6	100	53	6-12	35
Minturki	20.2	26.6		31.3	26.6	26.2	100	52	6-14	45
Minter	29.6	31.7		31.3	34.1	31.7	100	56	6-14	25
Pawnee	21.7	16.0		28.7	31.9	24.6	100	54	6-11	45
Iowin	25.2	27.5		32.4	31.8	29.2	100	54	6-13	40
Marmin	27.5	31.5		30.2	32.2	30.4	100	53	6-13	45
Iohardi	21.9	30.8		29.4	28.0	27.5	100	54	6-12	65
L. S. D.‡	6.0	1.8		3.1	1.8	1.8				

*Percent infection.
†Winterkilled
‡L. S. D.=least significant difference.

Soybean Variety Tests. The results of soybean variety tests are reported in Table 7.

Ottawa Mandarin has been a very reliable early variety. Blackhawk has a higher yielding potential and, in somewhat less variable seasons, is expected to yield more than an earlier variety. Chippewa, a new release, is about 2 to 3 days later than Ottawa Mandarin and is equal in yielding ability to Ottawa Mandarin and Blackhawk.

Table 7. Results of Soybean Variety Tests, 1949-54*

Variety	Relative Maturity†	Lodging Rating‡	Percent Oil 1949-53	1954 Yield	Bu/ A.
Chippewa	2.7	1.4	20.3	29.6	24.9
Blackhawk	8.3	1.9	20.4	29.9	25.1
Earlyana	9.9	2.9	19.6	27.9	24.4
Monroe	6.4	2.3	19.5	26.1	23.2
Ottawa Mandarin	0	1.3	19.4	28.2	24.4

*Conducted in cooperation with Field Crops Research Branch, A.R.S., U.S.D.A.
†Days later than Ottawa Mandarin.
‡Lodging score 1=excellent; 5=poor.

Corn Performance Tests. Many experimental corn hybrids are produced in the breeding plots each year. The better performing ones are tested in the South Dakota corn performance tests along with the best commercial hybrids available. The performance records of those which competed well enough to be named and released are presented in Table 8. S. D. 220 and S. D. 250 have been released recently. These hybrids have improved lodge resistance and yield well. The other hybrids perform satisfactorily at Brookings, although S. D. 220 is to be regarded as very early and S. D. 270 as full season.

A circular, "South Dakota Corn Performance Tests," is published annually and presents performance of the commercial hybrids tested, not only at Brookings, but also at other locations in the state. This circular can be obtained at county agents' offices or by writing the Editorial Department, Agricultural Experiment Station, College Station, South Dakota.

Table 8. Results of Corn Performance Tests, 1950-54

Variety	1954			2-Yr. Av.			3-Yr. Av.			4-Yr. Av.		5-Yr. Av.	
	Yield Bu./A	Moisture Percent	Root Lodging Percent	Yield Bu./A	Moisture Percent	Root Lodging Percent	Yield Bu./A	Moisture Percent	Root Lodging Percent	Yield Bu./A	Moisture Percent	Yield Bu./A	Moisture Percent
S.D. 220	69.6	23.8	0	68.6	21.4	1.3	66.3	21.0	3.2	59.6	25.2	—	—
S.D. 212	68.8	28.8	12.6	71.9	25.8	21.9	67.9	25.1	27.9	59.7	29.1	58.9	30.6
S.D. 224	76.4	27.2	6.1	77.3	24.7	7.6	72.4	23.9	12.4	63.3	29.2	63.1	30.3
S.D. 250	81.1	29.3	3.0	83.2	24.6	2.2	80.8	24.5	3.5	70.2	30.5	70.0	31.1
S.D. 262	79.1	30.6	13.5	82.8	27.5	15.9	78.6	26.3	19.0	67.1	32.7	66.6	33.7
S.D. 270	79.3	33.0	15.1	84.3	29.6	11.5	81.6	27.6	10.4	69.5	32.6	67.8	34.8
S.D. 400	77.1	33.3	13.2	83.8	29.2	9.4	74.8	29.0	10.4	64.3	35.3	63.7	36.3

Grain, Forage Sorghums, and Sudan Grass Variety Tests. The grain and forage sorghum and Sudan grass yields are reported in Table 9. Reliance and Norghum are adapted early maturing grain varieties. Rancher and 39-30-S are early maturing, low prussic acid forage sorghums. Piper is a low prussic acid Sudan grass adapted for pasture, hay, and fodder.

Table 9. Results of Sorghum and Sudan Grass Variety Tests

Variety	Cured Forage Lbs./A.	Yield Bu./A.	Date Pollinated	Height Inches
Grain Sorghums 5-yr. Av. (1949-53)				
Reliance		62.9	7-26	44
Norghum		64.7	7-25	49
Martin		38.2	8-10	44
Midland		38.0	8-8	45
Forage Sorghum and Sudan Grass 5-yr. Av. (1948-52)				
Rancher	14,653	38.1	7-30	72
39-30-S	14,154	42.3	7-29	71
Rox Orange	18,633	19.5	8-18	79
Axtel*	19,636	33.1	8-18	80
Norkan	18,701	44.7	8-14	76
Leoti Red	18,216	27.5	8-21	80
Commercial Sudan	6,114	20.4†	7-22	70
Sweet Sudan	6,959	20.2†	7-24	66
Piper Sudan	6,969	11.7†	7-24	71

*1948 and 1949 Atlas.
†4-year average 1949 Sudan grass seed shattered 35 to 60 percent before harvesting.

Alfalfa Variety Tests. The data reported in Table 10 are from a trial seeded in 1950. Previous studies at this station have proved that seed originating in Kansas, Oklahoma, Arizona, Chile, and Argentina lacks sufficient cold resistance to be grown safely here.

Bacterial wilt may infect alfalfa when grown in the eastern one-fourth of the state. Infection usually does not influence stand or plot yields until the third or fourth harvest year; the second cutting will be more affected than the earlier cutting. In the fifth and succeeding seasons the stands become noticeably thinned and yields markedly depressed. Ranger and Vernal are the only varieties available at present which are resistant in high degree to wilt. Ladak is still one of the highest yielding strains adapted to South Dakota and is recommended for all parts of the state except where wilt is known to be severe.

Table 10. Results of Recent Alfalfa Variety Trials

	1951	1952		1953	1954			
Variety or Strain	1st Cut August	1st Cut July 2	2nd Cut August	1st Cut June	1st Cut June	Cumulative 1st Cut	Average 2nd Cut	Average Seasonal Total
Ladak	0.97	2.91	0.95	2.00	1.73	2.21	0.96	3.17
Ranger	0.75	2.36	1.03	1.92	1.40	1.89	0.89	2.78
South Dakota Common	0.74	2.50	1.19	2.07	1.62	2.06	0.96	3.02
Sevelra	0.77	2.25	1.10	2.10	1.51	1.95	0.93	2.88
Nomad	0.79	2.12	0.80	1.87	1.40	1.80	0.80	2.60
Wisc. Syn C*	0.85	2.58	1.18	1.94	1.56	2.03	1.02	3.05
Atlantic	0.78	2.40	1.14	2.07	1.47	1.98	0.96	2.94
DuPuits	0.70	2.27	1.21	1.74	1.38	1.80	0.95	2.75
Talent	0.63	2.00	1.06	1.81	1.11	1.64	0.85	2.49
Williamsburg	0.72	2.26	1.13	1.95	1.48	1.90	0.93	2.83
Narragansett	0.84	2.52	1.19	1.98	1.48	1.99	1.02	3.01
A226	0.78	2.49	1.26	1.99	1.54	2.01	1.02	3.03
A228	0.94	2.86	1.09	1.94	1.63	2.14	1.02	3.16
A227	0.90	2.58	1.16	1.74	1.62	1.98	1.03	3.01
A229	0.91	2.67	1.14	2.25	1.64	2.19	1.03	3.22
Average	**0.80**	**2.45**	**1.11**	**1.96**	**1.50**	**1.97**	**0.96**	**2.93**

*A sister selection to Vernal.

Red Clover Variety Tests. Data for red clover varieties are given in Table 11. The yield tests of a number of regional strains collected throughout the Corn Belt and eastern Canada show relatively small differences among strains. During years of severe northern anthracnose disease infection, the Canadian Dollard has been superior; otherwise, locally grown seed is about as good as any of the tested strains for the South Dakota farmer. Dollard is definitely superior on plots where it is carried over to the second harvest year, although all strains are appreciably less productive.

Table 11. Yield Performance of Red Clover Varieties

Variety	Test of Dry Matter Per Acre 1951 1st Cut August	1952 1st Cut July 2	1952 2nd Cut August	Total 1952	1952 Nursery, Harvested in 1953—the 2nd Harvest Year
Emerson	1.84	2.24	1.33	3.57	0.95
Kenland	2.07	2.32	1.18	3.50	0.73
Dollard	2.29	2.16	1.11	3.27	1.56
Libel	2.04	1.89	1.21	3.10	1.26
Mammoth	—	2.77	0.48	3.25	1.19
Rahn	1.79	2.06	1.33	3.39	0.97
Van Fossen	1.99	2.42	1.09	3.51	0.79
Wegener	1.82	2.14	1.03	3.17	1.11
Ottawa	1.89	2.43	1.09	3.52	1.08
Midland	2.10	2.26	1.02	3.28	0.90
Pennscott	1.67	2.33	0.85	3.18	0.65
Average	**1.95**	2.27	1.07	**3.34**	1.01

Birdsfoot Trefoil Variety Tests. The strains of birdsfoot trefoil listed in Table 12 were established in 1951. Birdsfoot trefoil strains are either of the narrowleaf or broadleaf form. The narrowleaf form is not grown commonly in the Corn Belt on account of insufficient vigor and hardiness. Among the broadleaf forms listed, only Empire and Mandan 1116 are of the domestic type. Differences in flower production and dormancy after cutting are striking and significant. The narrowleaf forms failed to survive the winter of 1952-53, and during the following winter of 1953-54 all of the European broadleaf types succumbed to winter hazards.

On the basis of these observations we must conclude that (a) birdsfoot trefoil strains yield on the average about two-thirds as much hay in

Table 12. Results of Birdsfoot Trefoil Variety Tests

Variety or Strain	Stand Percent Nov. 1951	Stand Percent May 1952	Vigor* Nov. 1951	Vigor* May 1952	Percent Flower Production	Recovery in Inches After Cutting July 18	Recovery in Inches After Cutting Aug. 14	1952 Yield T/A (1 Cutting)	1953	1954
Cascade (Wash.)	82	78	2.3	1.3	22	4.0	9.7	1.90	1.49	.....†
Granger (Oregon)	82	75	2.3	1.0	27	3.7	9.3	1.90	1.54	.....†
Viking (New York)	78	73	2.7	1.7	10	3.0	9.0	2.01	1.91	.....†
P.I. 188101 (Italy)	62	73	4.1	1.3	12	4.0	9.0	1.96	1.46	.....†
P.I. 188867 (Italy)	45	60	6.0	1.7	27	3.0	9.7	1.64	1.44	.....†
Empire (New York)	82	73	2.3	2.7	2	1.0	4.7	2.66	1.73	2.00
Mandan (1116)	70	75	3.5	2.0	2.7	1.0	4.7	2.36	1.36	1.70
Oregon (narrowleaf)	82	42	2.3	3.0	20	0.6	1.7	1.35	.....†	.....†
New York (narrowleaf)	85	63	7.3	7.3	67	0.5	2.0	1.24	.....†	.....†
S.D. Source (Empire type)	....	—	—	—	—	—	—	—	—	1.80
Average								**1.89**	**1.56**	**1.83**

*Score 1=excellent; 10=poor.
†Severe winterkilling—stands less than 10% of initial.

a season as alfalfa (b) critical comparisons of trefoil strains should be made under pasture conditions (c) only domestic strains of or related to the Empire type are at present well enough adapted in South Dakota to be used safely.

Sweet Clover Variety Tests. Although sweet clover in South Dakota is grown primarily for green manure, a considerable portion of the acreage is pastured during a part of the growing period, and many fields are used for seed production. A simple evaluation based on hay yields, therefore, does not adequately appraise the different strains for these varying purposes. A test based on root weights as well as top weights would appear to be more valuable from the green manure standpoint; two of the columns of Table 13 indicate the dry root weights in the upper 8 inches of soil and the dry top yields produced by first-year sweet clover. On these bases, the annual Hubam appears definitely inferior for green manure purposes. Annual Israel appears more promising, but some of the biennials produced over a ton of roots per acre in the first season and in addition produced over a ton and a half of tops.

Table 13. Performance of Sweet Clover Varieties

Variety or Strain	Growth Characteristics	Yield in Tons Dry Matter/Acre 1952	1953	1954	3-Yr. Ave.	Yield of First Year Growth, 1954 Roots Lbs. /A.	Tops Tons /Acre	Pounds of Nitrogen 1954 Roots Lbs. /A.	Tops Lbs. /A.
Spanish	Tall, coarse, white flower, maturity later than common white	2.29	3.90	1.89	2.69	2929†	2.28†	87.6	136.3
Willamette	Tall coarse	2.73	—	—	2.73*	1861	1.79	51.6	98.5
Alpha	Mid-tall, fine stem, white flower	0.00	0.66	—	0.66*	—	—	—	—
Common White	Tall, coarse, white flower	2.24	3.47	2.21	2.64	2377	0.81	72.3	50.7
Common Yellow	Tall, coarse, yellow flower	2.25	3.68	2.38	2.77	2671	0.97	71.8	59.9
Common Yellow Selection	Similar to parent strain	—		—	—	2443	1.32	67.4	75.2
Artic	Mid-tall, coarse, early white flower	1.51	3.15	—	2.33*	—	—	—	—
Madrid	Tall, coarse, yellow flower, maturity similar to common yellow	1.85	3.40	1.84	2.36	2533	1.70	62.8	99.6
Brandon Dwarf	Short, branching fine stem, white flower, slightly earlier than common white	2.24	3.56	2.21	2.67	—	—	—	—
Evergreen	Tall, coarse, white flower, late	2.25	4.02	2.08	2.78	2604†	1.68†	74.5	96.4
Wisconsin Int. I	Tall, coarse, white flower, late	0.50	—	1.83	1.16*	—	—	—	—
Wisconsin A-46	Tall, coarse, yellow flower, later than common yellow	3.20	3.77	—	3.48*	2605	1.48	67.2	80.2
N—1	Mid-tall, branching, fine stem, white flower, late	3.22	3.38	2.05	2.88	1627	1.57	49.1	94.8
N—7	Biennial type grown for first time in 1954	—	—	—	—	1560	1.51	49.0	93.3
N—9	Biennial type grown for first time in 1954	—	—	—	—	1597	1.30	50.2	77.5
Melilotus wolgica	(Biennial species)	—	—	—	—	984	1.12	26.5	75.9
Melilotus taurica	(Biennial species)	—	—	—	—	798	0.52	24.6	30.9
Israel	Annual, white flowered tall, coarse	—	—	—	—	1200	2.41	12.2	119.5
Hubam	Annual, mid tall, coarse white flowered	—	—	—	—	480	1.80	3.1	95.0

*Based on results of less than 3 years.
†Based on one plot only.

Grass Species and Variety Test. Hay yields of different species and strains of grasses growing alone and with alfalfa are shown in Table 14. Ree wheatgrass and the Bromegrasses are the high-yielding entries. Little difference was noted in the yielding ability of the bromegrass in this test, but there was a definite difference between the bromegrasses and crested wheatgrass, Kentucky bluegrass and creeping red fescue. The low-yielding grasses also depressed the yield when in mixtures with alfalfa. In no case has the grass alone yielded as much as the mixture with alfalfa.

Table 14. Yield of Grasses in Tons Per Acre When Alone and With Alfalfa 1949-53

	Grown Alone				Grown With Alfalfa			
	1951	1952*	1953*	5-Yr. Av.	1951	1952*	1953*	5-Yr. Av.
Homesteader bromegrass	2.29	1.18	1.23	2.05	3.47	1.98	2.13	2.85
Lyons bromegrass	3.06	.91	1.41	2.10	4.10	2.15	2.10	2.95
Lancaster bromegrass	2.47	.88	1.53	1.91	3.92	2.28	2.41	3.09
Lincoln bromegrass	2.73	1.02	1.82	2.17	3.82	2.09	2.44	2.98
Ree wheatgrass	2.85	1.18	1.47	2.19	3.83	2.36	2.53	3.11
Standard crested wheatgrass	2.50	1.03	1.20	1.58	3.51	2.24	2.55	2.91
Kentucky bluegrass	2.05	.74	0.53	1.25	3.47	2.05	2.49	2.73
Creeping red fescue	2.88	.83	0.78	1.53	3.15	2.04	2.22	2.73
Ranger alfalfa	3.42	1.68	2.13	2.47	—	—	—	—

*One cutting.

Bromegrass Variety Test. Yields of 13 bromegrass varieties with and without alfalfa are shown in Table 15. Ree wheatgrass, included in this test to measure its yield in relation to bromegrass strains, was found to give the highest yield both by itself and with alfalfa. Homesteader bromegrass,

Table 15. Uniform Bromegrass Test Showing Yield in Tons per Acre (One Cutting)

	Grown Alone					Grown With Alfalfa				
	1951	1952	1953*	1954	4-Yr. Ave.	1951	1952	1953	1954	4-Yr. Ave.
Ree	4.89	2.58	3.17	1.18	2.95	5.16	2.62	2.81	2.21	3.20
Homesteader	4.10	2.58	2.54	.95	2.54	3.18	2.42	2.51	2.02	2.53
Fischer	4.29	2.30	2.03	1.07	2.42	3.48	2.58	2.56	2.06	2.67
Lancaster	4.21	2.55	1.78	1.05	2.40	3.42	2.50	2.80	1.67	2.60
Achenbach	3.73	2.42	2.29	.99	2.36	3.64	2.60	2.65	2.05	2.74
Manchar	3.55	2.72	2.26	.92	2.36	3.48	2.40	2.59	1.96	2.61
Storley	3.76	2.50	2.32	.81	2.35	3.84	2.50	2.74	2.16	2.81
Mandan 404	3.88	2.20	2.29	.85	2.30	3.66	2.85	2.53	2.04	2.77
Canadian	4.10	2.45	1.78	.74	2.27	3.28	2.45	2.61	2.02	2.59
B. inermis 12	3.89	2.12	2.01	1.05	2.27	3.62	2.55	2.60	1.91	2.67
Elsberry	3.85	2.28	2.05	.85	2.26	3.48	2.25	2.86	2.27	2.71
Martin	3.30	2.50	2.18	.99	2.24	3.52	2.45	2.62	1.94	2.63
Lincoln	3.96	2.28	1.76	.94	2.23	3.80	2.52	2.73	2.12	2.79
Lyons	3.57	2.12	1.78	1.20	2.17	3.81	2.45	2.63	1.98	2.72
Mean Average	**3.93**	**2.40**	**2.16**	**.97**	**2.36**	**3.67**	**2.51**	**2.66**	**2.03**	**2.72**

*300 lbs. of ammonium nitrate applied.

which is adapted to South Dakota conditions, yielded next highest by itself. In general there was little difference between the various varieties of bromegrass when in mixture with alfalfa. In 1953, an application of 300 lbs. of ammonium nitrate maintained the average yield for all plots of grass alone at 2.16 tons while the mixture yielded 2.66 tons per acre; but when no nitrogen was added in 1954 the grass alone yielded only one-half as much as the mixture with alfalfa.

Crop Cultural Tests

Rate of Planting Corn. Table 16 gives the corn yields and the number of plants per hill. Corn was planted thick and thinned as nearly as possible to two, three, and four plants per hill. Hills were 42 inches apart in each direction. Three kinds of corn were used: early, medium, and full-season corn. Average results indicate that highest yields were secured from four plants per hill.

Table 16. Effect of Rate of Planting Corn on Yield 1945-54*

	Planted May 1			Planted May 20		
Number of Plants Per Hill	Early Corn	Medium Corn	Full-Season Corn	Early Corn	Medium Corn	Full-Season Corn
2	41.5	47.9	57.6	51.3	50.7	51.8
3	49.7	57.2	62.1	57.1	60.5	60.4
4	56.2	57.1	64.9	59.8	64.8	59.7

*Yields are in bushels per acre of shelled corn with 15 percent moisture.

Date of Planting Corn. The yields and moisture content of corn planted on two dates are given in Table 17. Three kinds of corn were used: an early corn, a corn with a medium growth period, and a full-season corn. The 10-year data indicate that with early and medium strains greater yields were obtained in the east-central area by planting corn May 20 than by planting it May 1. The full-season strain produced slightly higher yields when planted May 1. However, corn planted on May 20 contained more moisture than that planted earlier.

Table 17. Effect of Date of Planting Corn on Yield and Moisture Content, 1945-54*

	Planted May 1		Planted May 20	
Kind	Yield Bu. Per Acre	Percent Moisture	Yield Bu.	Moisture Content
Early corn	49.1	22.2	56.0	27.9
Corn with medium growth period	53.8	26.9	58.4	29.6
Full-season corn	61.5	30.7	57.3	35.6

*Yields are in bushels per acre of shelled corn with 15 percent moisture.

Dates of Planting Sorghums. Three sorghum varieties were planted at weekly intervals from May 10 to June 14. Yields are given in Table 18. Reliance yields were uniformly high on all except the last date of planting. Norghum outyielded Reliance on the first two plantings. It is advisable to delay planting until the later part of May and kill as many weeds as possible before planting. The best time to plant sorghums is from May 20 to June 1.

Table 18. Yields in Bushels Per Acre of Sorghums Planted on Six Dates, 1950-53

Variety	Dates of Planting					
	May 10	May 17	May 24	May 31	June 7	June 14
Reliance	55.8	52.2	53.3	49.4	52.4	30.3
Norghum	61.8	57.9	49.4	46.1	44.4	28.0
Sooner Milo	43.7	42.4	34.4	34.2	25.3	12.4

Soil Experiments

Crop Yields on Fertility Plots. The object of this trial was to determine the effects of various fertilizers, applied at various rates and combinations, on the yield of crops. The following fertilizers and rates per acre were used: 20 pounds of nitrogen applied as ammonium nitrate (60 pounds of 33-0-0), 20 pounds of phosphoric acid applied as treble superphosphate (47 pounds of 0-43-0), and 30 pounds of potassium oxide applied as muriate of potash (60 pounds of 0-0-60). Fertility of the soil on the farm had been maintained at a high level previous to the establishment of the fertilizer trials in 1942. Results of the fertilizer trials for the period 1942-52 and for the individual years 1953 and 1954 are shown in Tables 19, 20, 21. The rotation used on the fertilizer plots is corn-oats-wheat.

Table 19. Corn Yield on Fertility Plots

Treatment*	Average Yield in Bushels Per Acre		
	1942-52	1953	1954
None	46.2	64.2	52.2
Nitrogen	48.2	72.3	51.8
Phosphorus	48.7	67.0	51.0
Potassium	50.1	64.1	55.1
Nitrogen + phosphorus	52.1	79.9	55.8
Nitrogen + potassium	50.5	73.3	54.7
Phosphorus + potassium	52.2	72.7	53.4
Nitrogen + phosphorus + potassium	49.0	67.8	48.8

*Nitrogen was applied at the rate of 20 pounds per acre as 60 pounds of ammonium nitrate; phosphorus at the rate of 20 pounds of phosphoric acid as 47 pounds of treble superphosphate; potassium at the rate of 30 pounds of potassium oxide as 60 pounds of muriate of potash.

Corn is most responsive to nitrogen and phosphorus fertilizer. Oats is very responsive to nitrogen fertilizer. Including phosphorus with the nitrogen usually results in the largest yields. The influence of fertilizer on the yields of oats was more pronounced in 1953 and 1954 than for the earlier period from 1942-52. This is probably due to the effects of declining soil fertility. The yield of oats was increased by every fertilizer treatment that included nitrogen.

Table 20. Oats Yield on Fertilizer Plots

Treatment*	Average Yield in Bushels Per Acre		
	1942-52	1953	1954
None	63.9	38.1	38.1
Nitrogen	68.5	68.1	58.1
Phosphorus	64.8	43.8	38.6
Potassium	62.2	41.0	34.3
Nitrogen + phosphorus	72.9	65.8	66.5
Nitrogen + potassium	71.3	59.6	53.2
Phosphorus + potassium	65.2	40.6	40.0
Nitrogen + phosphorus + potassium	71.2	73.4	51.5

*See footnote Table 19.

The data in Table 21 indicate that a combination of nitrogen and phosphate fertilizer is the most effective fertilizer treatment for increasing wheat yields. Table 22 summarizes the effect of a nitrogen, phosphorus, and potassium fertilizer applied at two rates to a corn-oats-wheat rotation. It may be noted the lower rates of application are as effective for increasing crop yields as the double rate. Potassium did not have any beneficial effect.

Table 21. Wheat Yields on Fertilizer Plots

Treatment*	Average Yield in Bushels Per Acre		
	1942-52	1953	1954
None	19.8	10.4	12.1
Nitrogen	22.6	12.7	9.2
Phosphorus	19.9	9.8	14.1
Potassium	20.3	11.4	12.0
Nitrogen + Phosphorus	26.1	16.0	14.9
Nitrogen + Potassium	23.6	14.3	12.0
Phosphorus + Potassium	21.6	10.1	16.4
Nitrogen + Phosphorus + Potassium	24.8	14.3	13.2

*See footnote Table 19.

Table 22. Effect of Various Rates of Fertilizers on Crop Yields

Treatment*	Average Yields in Bushels Per Acre for the Periods Indicated					
	Corn		Oats		Wheat	
	1954-52	1953-54	1944-52	1953-54	1944-52	1953-54
2 Nitrogen—Phosphorus—Potassium†	50.8	60.9	77.6	62.5	25.6	15.9
Nitrogen—2 Phosphorus—Potassium	50.3	64.0	72.8	60.5	24.6	11.5
Nitrogen—Phosphorus—2 Potassium	51.1	64.9	72.5	55.8	25.4	15.3
2 Nitrogen—2 Phosphorus—2 Potassium	49.1	66.3	77.9	68.9	26.7	11.2
Nitrogen—Phosphorus—Potassium	50.3	58.3	71.2	62.5	24.8	13.7
Nitrogen—Phosphorus	53.5	67.8	74.7	66.1	27.9	15.4
None	46.5	58.2	63.3	38.1	19.5	11.2

*See footnote Table 19.
†The figure 2 before the fertilizer indicates the rate was doubled.

Tillage and Crop Residue Experiments. The purpose of this trial was to determine the effect of tillage, crop residues, and fertilizers applied with residues on the yields of corn, oats, and wheat in a 3-year rotation. The average crop yields from 1942 to 1952 and the yields for the individual years, 1953 and 1954, are given in Tables 23, 24, and 25.

Return of crop residues to the soil, with plowing as the tillage practice, tended to produce an upward trend in crop yields which is becoming more pronounced from year to year. The beneficial effect of crop residues on the yields of corn, with plowing as the tillage practice, was especially noticeable in 1954, a year of low summer rainfall. Some years it is difficult to secure a stand of corn on the subsurface-tilled plots and, consequently, the corn yield on these plots is reduced.

In 1954 the yields of corn and oats on the subsurface-tilled plots were increased by the application of residues and manure; residues and nitrogen; and residues, nitrogen, and phosphorus. The wheat crop on the tillage and residue plots in 1953 and 1954 did not show much response to the various soil treatments because the yield of this crop was reduced by rust. The rate of fertilizers applied was the same as for the fertility plots.

Table 23. Corn Yields on Tillage and Residue Plots

Treatment	Average Yields in Bushels Per Acre		
	1942-52	1953	1954
Plowing	48.8	59.3	50.6
Plowing with residue	51.4	64.6	59.3
Subsurface	47.9	46.9	51.6
Subsurface with residue	48.4	43.7	53.0
Subsurface with residue and manure	50.0	54.7	61.1
Subsurface with residue and nitrogen	47.1	44.5	56.5
Subsurface with residue and phosphorus	47.7	44.7	55.4
Subsurface with residue, nitrogen, and phosphorus	46.6	51.4	58.6

Table 24. Oats Yield on Tillage and Residue Plots

Treatment	Average Yields in Bushels Per Acre 1942-52	1953	1954
Plowing	57.3	40.4	34.2
Plowing with residue	61.4	45.5	42.4
Subsurface	58.4	42.2	37.1
Subsurface with residue	61.6	56.6	36.6
Subsurface with residue and manure	63.3	61.5	59.9
Subsurface with residue and nitrogen	63.4	64.5	49.1
Subsurface with residue and phosphorus	64.2	50.8	38.2
Subsurface with residue, nitrogen, and phosphorus	64.6	69.0	52.7

Table 25. Wheat Yields on Tillage and Residue Plots

Treatment	Average Yields in Bushels Per Acre 1942-52	1953	1954
Plowing	18.8	7.1	4.9
Plowing with residue	20.6	11.8	6.1
Subsurface	18.1	7.3	4.3
Subsurface with residue	18.0	8.7	5.3
Subsurface with residue and manure	22.0	12.2	7.6
Subsurface with residue and nitrogen	22.5	12.5	6.7
Subsurface with residue and phosphorus	20.9	8.9	6.3
Subsurface with residue, nitrogen, and phosphorus	24.7	14.8	7.6

Method of Soil Preparation. The influence of different methods of soil preparation on the yields of crops in a 3-year rotation, corn-oats-wheat, is shown in Tables 26, 27, 28. In this trial, none of the crop residues were returned to the soil and no fertilizer was used.

For corn the data indicate that plowing is the most effective method for seedbed preparation. Oats yields in 1954 show larger differences due to method of seedbed preparation than in previous years. Plowing produced the highest oats yield in 1954. A comparison of the four methods of seedbed preparation shows that plowing has consistently produced the higher yields of wheat.

Table 26. Corn Yields on Tillage Plots

Treatment	Average Yields in Bushels Per Acre 1942-52	1953	1954
Plow 4″	46.5	59.6	54.9
Plow 7″	48.1	63.5	53.5
Plow 10″	47.0	62.8	53.7
Subsurface	44.8	48.0	47.1
One-way	45.2	52.0	47.7
Double disc	42.1	49.2	43.3

Table 27. Oat Yields on Tillage Plots

Treatment	Average Yields in Bushels Per Acre 1942-52	1953	1954
Plow 4"	65.5	44.3	40.5
Plow 7"	61.0	34.0	39.4
Plow 10"	66.1	45.9	44.4
Subsurface	59.5	46.8	34.0
One-way	60.0	41.3	30.5
Double disc	58.2	40.5	30.6

Table 28. Wheat Yields on Tillage Plots

Treatment	Average Yields in Bushels Per Acre 1942-52	1953	1954
Plow 4"	19.5	10.2	8.7
Plow 7"	19.0	9.2	6.9
Plow 10"	20.6	10.3	7.4
Subsurface	17.3	6.0	7.9
One-way	18.1	7.8	6.4
Double disc	16.3	6.7	6.0

Method of Managing Sweet Clover Rotation. Sweet Clover was plowed under as a green manure crop at two different dates. Its effect on yields of corn and wheat, with and without phosphate fertilizer, is shown in Table 29. The sweet clover was seeded with the wheat crop and the following year was plowed under for a green manure crop. It was either plowed under in June or mowed and allowed to grow until August and then plowed under.

The wheat yields have been substantially higher in the sweet clover rotation than in the corn-oat-wheat rotation. Corn yields are somewhat higher where sweet clover is plowed in August.

Table 29. Effect of Sweet Clover Rotation on Crop Yields

Treatment	1944-53 Corn	1944-53 Wheat	1953 Corn	1953 Wheat	1954 Corn	1954 Wheat
Sweet clover plowed June 15	49.1	26.4	65.4	15.9	55.9	12.3
Sweet clover plowed June 15 with phosphorus fertilizer	50.3	29.2	69.7	16.3	56.8	14.3
Sweet clover plowed August 1	52.6	28.2	73.1	16.6	60.7	14.7
Sweet clover plowed August 1 with phosphate fertilizer	53.3	28.9	75.7	18.4	56.8	13.5
No legume, corn-oats-wheat rotation	46.0	18.4	64.2	10.4	52.2	12.1
Corntinuous corn or wheat	44.9	19.5	56.0	10.8	46.6	11.5

Effect of Grass on Crop Yields. The effect of grass rotations on the yields of corn is shown in Table 30. The yields of corn, following 6 years of grass in 1954, were lower than the corn yields in a corn-oats-wheat rotation or continuous corn. The yield of corn following crested wheatgrass was significantly higher than following bromegrass.

Depletion of subsoil moisture by the grasses was a factor for causing the lower yields of corn in the grass rotation.

Table 30. Effect of 6 Years of Grass on Corn Yields

Rotation	Corn 1954 Yield Bu./A.
6 years bromegrass, 1 year corn	31.1
6 years crested wheatgrass, 1 year corn	44.6
Corn-oats-wheat rotation	52.2
Continuous corn	46.6

Effect on Yields of Growing Crops Continuously. What happens to yields when crops are grown continuously without the use of soil improvement practices is shown in Table 31.

The data in this table show that the crop yields for the first 6-year period are higher than for the second 5-year period. The yields of barley and oats for the 1953-54 period are lower than the previous periods. Rye yields have remained relatively constant. Wheat yields have declined, but the abrupt decline in 1952-53 is in part due to rust damage. Corn yields for 1953-54 are above those of previous years. Chemical analysis of the soils on the continuous plots shows that these soils are undergoing a constant decline in soil nitrogen and organic matter.

Table 31. Effects of Continuous Cropping on Yields

	Average 1942-47 Inclusive Bu./A.	Average 1948-52 Inclusive Bu./A.	Average 1953-54 Inclusive Bu./A.
Corn	47.9	42.4	52.3
Barley	37.1	34.8	31.8
Oats	58.6	46.2	44.9
Rye	29.8	26.0	26.2
Wheat	21.4	17.3	11.2