Effect of 39 Years of Cropping Practices on Wind Erodibility and Related Properties of an Irrigated Chestnut Soil

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Effect of 39 Years of Cropping Practices on Wind Erodibility and Related Properties of an Irrigated Chestnut Soil[1]

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ABSTRACT

In April 1951, a portable wind tunnel was set up at the Scotts Bluff Substation on plots that were planted to sugar beets and potatoes. The soil losses from wind under controlled conditions were measured on manured and non-manured plots from (i) a 3-year rotation of barley, potatoes and sugar beets and (ii) a 6-year rotation of barley with alfalfa, alfalfa 3-years, potatoes and sugar beets. On these and other plots, size-fractions of air-dried clods from the surface 2-inches of soil were separated by means of rotary sieves. Each size-fraction was analyzed for the apparent density of clods, total nitrogen content, and moisture content at 15-atmosphere tension.

The cropping and manurial practices showed a marked effect on the soil losses from wind. Alfalfa in the rotation was superior to manure application in reducing soil losses. Application of 12 tons of barnyard manure on potato plots in a 3-year rotation reduced the soil loss from 74,500 pounds per acre to 2,720. The soil loss on non-manured plots in the 6-year rotation was 970 pounds per acre. The beet plots, in a cropping system and manurial application similar to potato plots showed a smaller regimen of soil losses.

Mechanical stability of clods was determined by their resistance to break-down as a result of re-sieving. It was greatest in plots cropped to continuous barley, followed in order by beets, corn, and potatoes. Mechanical stability was greater in manured plots than in non-manured.

The application of manure or growing of alfalfa in the rotation effected a marked reduction in the apparent density of clods and increased the total nitrogen content and the moisture content at 15-atmosphere tension. Alfalfa was superior to manure in effecting these changes in soil properties.

A series of rotation experiments was established in 1912 on irrigated Tripp very fine sandy loam at the Scotts Bluff Field Station, Mitchell, Neb. The experiments were planned to determine the effects of rotations, alfalfa in the rotation, and the applications of manure upon the yield of crops under irrigation. The results obtained have established definitely the importance of alfalfa in the rotation and of manure application for the production of irrigated crops in western Nebraska. The effect of cropping and manurial practices on several chemical properties of soil has been reported (5). In 1949 to 1951, the plots were measured for the effects of the practices on the physical properties of soil.

Tripp very fine sandy loam in the western part of Nebraska is subject to wind erosion during the portion of the year when the soil is bare. In this section of the country it is claimed that one of the greatest benefits from alfalfa or application of manure is to improve the structural properties of soil. This is assumed to lessen soil losses from wind. Experimental data on soil erodibility by wind are not available for irrigated soils in the Great Plains. It was thought also that any small differences in the physical properties of soil as a result of past management practices would be reflected by the amount of soil loss from wind.

Procedure

Rotation plots. — The rotations were established in 1912 on plots ¼ acre in area. The number of plots included in any one rotation was determined by the length of rotation. Each crop in the rotation was grown annually on one of the plots. Detailed descriptions of the rotations and the cultural practices employed have been reported previously (4).

The soil losses from wind were determined by wind tunnel on plots cropped either to sugar beets or potatoes in the 3- and 6-year rotation (see table 1). The crops were harvested in the fall of 1950 and the determinations were made in the spring of 1951. For purposes of contrasting soil losses from wind, a field with a surface soil texture of loamy sand located 5 miles from the substation was tested also.

Seven out of 21 plots were tested for erodibility by use of the wind tunnel. The wind erodibility of soils from the remaining 14 plots was estimated by determining the state and stability of dry clods. The rotations and crops for the 21 plots are tabulated in table 3.

Operation of Wind Tunnel. — During the period April 3–8, 1951, four settings of the wind tunnel were made on each of the seven plots tested. For each setting, the tunnel was operated at four progressively increasing wind speeds or surface drag levels. For each drag level, the 3 by 30 foot surface covered by the tunnel was permitted to erode until the soil became stabilized. Increment samples of soil obtained at four heights at the end of the tunnel for each drag level of the wind afforded the basic data for computing soil loss. The surface drag level of the wind and magnitude of the surface roughness were gaged from tunnel pressure readings. The procedure has been explained previously (7).

Determination of Residue. — Amounts of crop residue on the surface of plots tested with the wind tunnel were determined by sampling. Surface residue was hand picked from triplicate meter-

Table 1.—Soil losses on exposed surfaces of plots to wind drag of 3,000 pounds per acre as affected by manurial and cropping practices.

Treatment of plot	Crop	Soil loss, pounds per acre	Ridge roughness, inches	Residue, tons per acre	Erodible fraction <0.42 mm, per cent
		3-year Rotation			
Non-manured	Potatoes	74,500	0.32	0.040	62.3
Manured	Potatoes	2,720	1.59	0.085	53.4
Non-manured	Beets	1,190	1.01	0.106	29.3
Manured	Beets	830	1.39	0.131	37.5
		6-year Rotation			
Non-manured	Potatoes	970	1.41	0.252	43.7
Manured	Potatoes	1,130	1.64	0.209	39.3
Manured	Beets	840	1.87	0.256	25.1
		Field with a Surface Texture of Loamy Sand			
	Rye	210,000	1.34	0.562	89.8

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square areas on each plot. The weights were computed on an oven-dry basis.

Analysis of Soil. — Size distribution of dry clods from 21 plots was made by use of an improved rotary sieve (2). Triplicate samples of the surface soil to a depth of 1 to 2 inches were obtained with a shovel. Sievings of these soil samples into 13 size fractions (see table 4 for the diameters of clods) were performed at the Substation at Mitchell, Neb., shortly after the samples were obtained in the field. Proportions by weight of dry fraction <0.105 mm in diameter were determined subsequently by gravity-sedimentation in the carbon tetrachloride at the Manhattan Laboratory. The quality of the aggregates in the 13 size-fractions was measured as follows:

(i) The relative resistance of clods to break-down by mechanical forces, known as mechanical stability, was determined by resieving fractions > 0.84 mm. in diameter. Mechanical stability is equal to $\frac{W_1}{W}$ 100, where W is the weight of clods > 0.84 mm after first sieving and the W_1 is the weight of those clods after the second sieving.

(ii) The densities of clods for each size fraction <6.4 mm in diameter were determined by the bulk density method outlined by Chepil (1). For clods > 6.4 mm in diameter the density was obtained by coating the clod with paraffin (59° C) and finding the displaced weight in water.

(iii) The total nitrogen contents were determined.

(iv) The moisture contents at tension of 15-atmospheres were determined.

Results

The primary factors governing the amount of material eroded from a given plot by the controlled air flow of the wind tunnel are: (a) the quality and size of the dry clods, (b) the level of surface drag of the wind, (c) the roughness of plot surface, and (d) the amounts of surface residue. For purposes of this study the amount, kind, and placement of residue on different plots and the quality and size of the clods were considered as variables associated with the cultural system. For each setting of the wind tunnel on a given plot the quantity of soil loss is a function of the surface drag and the surface roughness of the site.

SOIL LOSSES FROM WIND TUNNEL TESTS

To compare wind erosion losses from various plots some interpretative standard of comparison must be selected. Reasonable results which appear to approximate the performance under atmospheric conditions have been obtained previously by comparing soil losses from wind at values of surface drag, τ, equal to 3,000 pounds per acre. The values of soil losses are given in table 1. Based on prior experience with the wind tunnel, soil losses of 2,000 pounds per acre are indicative of a wind erosion problem in the field. The minimum soil losses of 830–840 pounds per acre were obtained on beet plots which had been manured. The greatest loss of soil 74,500 pounds per acre was from a 3-year rotation, non-manured plot following potato harvest. The application of 12 tons of manure in the same rotation every three years reduced the soil loss to 2,700 pounds per acre. However, the incorporation of three years of alfalfa in the rotation system was of greater benefit than the application of manure. The soil loss on non-manured plots in the 6-year rotation was 970 pounds per acre. The beet plots in a similar cropping system and manurial application in the same rotations showed a smaller regimen of soil losses.

The high soil loss from the non-manured potato plot in a 3-year rotation was associated with the high percentage, 62.3, of erodible fraction < 0.42 mm in diameter, and a low amount of residue of 0.040 tons per acre. The soil loss varied inversely with the ridge roughness for the particular crop.

The 210,000 pounds of soil loss per acre from the field with a surface texture of loamy sand was obtained in a 30-minute test period. The soil surface was not stabilized at the end of this period. Of interest is the fact that 0.562 tons per acre of residue was present on the plot. This amount of residue was greater than for any other plot studied at the substation. It is apparent that very large quantities of residue are necessary to stabilize a sand having about 90% of its fractions of a size less than 0.42 mm in diameter.

The relationship of the quantity of soil eroded from a given plot, X, to the surface drag, τ, and to the surface roughness, K, is given in table 2. The exponential equations for all plots were derived by multiple curvilinear regression procedures. Each is the average relationship and gives equal consideration to all data obtained from all tests on a given plot. The standard deviation from regression (expressed as a logarithm) and the regression coefficient of each soil loss equation are given also in table 2.

From table 2 it will be noted that soil loss varies approximately as the cube of the surface drag and inversely with the surface roughness. The manured plots both for potatoes and beets show a larger coefficient of K than the non-manured plots. The effect of alfalfa in a rotation (6-year) increased the coefficient of K. The regression coefficient varied from 0.874 to 0.967 for several equations. The square of the regression coefficient is an indicator of the proportion of the variability accounted for by regression. This value varied from 77 to 93 per cent.

STATE AND STABILITY OF DRY CLOD STRUCTURE

The state and stability of dry clod structure on plots after potatoes, beets, corn, and barley as affected by 39 years of cropping and manurial practices are shown in table 3. The size distribution of dry clods is represented by the geometric mean diameter (6). One of the most significant features of the results of analyses is that the application of manure, in general, decreased the percentage of erodible fraction < 0.42 mm in diameter and increased the geometric mean diameter of clods. The effect of alfalfa was similar to that of manure. Thus, the plots in beets in 3-year rotation with manure showed 37.5% of erodible fraction and that in potatoes 53.4%; whereas the three years of alfalfa in the non-manured rotation decreased the erodible fraction to 33.7% in the beet plot and to 43.7% in the potato plot.

The amount of soil material eroded by wind varies approximately with the erodible fractions <0.42 mm in diameter which serves, therefore, as a rough index of soil erodibility (1, 3). Surface soil containing about 40% or more of the erodible fraction, depending on the amount of residue on the surface, affords a wind erosion hazard. The plots with continuous potatoes or corn are subject to large soil losses from wind as judged by the respective percentages, 50.7 and 56.3 of erodible fraction. The application of manure to these plots decreased the percentage by 10 but still left the surface of plots susceptible to wind erosion.

The soil fraction <0.105 mm in diameter is capable of being lifted by wind and carried into the atmosphere. The quantity of this fraction was more or less inversely proportional to the quantity of clods >0.84 mm in diameter. The ratio of fine dust <0.02 mm to the total dust content <0.105 mm varied with different crops and manurial treatment. In general, manured crops showed this ratio to be higher than the corresponding non-manured crops. The ratio seems to vary directly with the degree of cloddiness. It is evident that some of the fine dust is the residue resulting from decomposition of manure.

Mechanical stability, as determined by resistance of clods > 0.84 mm in diameter to breakdown as a result of re-sieving was greatest in continuous barley, followed in order by beets, corn and potatoes. Mechanical stability varied directly with the degree of soil cloddiness which is reflected by the values of geometric mean diameter of clods. In general the mechanical stability was greater in manured land than in non-

Table 2.—Regression equations for soil loss from wind tunnel tests on plots cropped to potatoes and beets.

Treatment	Crops	Regression equation for soil eroded*			Standard deviation	Regression coefficient
		3-year Rotation (Potatoes, Beets, Barley)				
Non-manured.....	Potatoes	Log X = 3.4485	log τ − 0.5451	log K − 7.4290	0.1492	0.874
Manured.........	Potatoes	Log X = 3.1834	log τ − 0.8724	log K − 7.4580	0.1015	0.934
Non-manured.....	Beets	Log X = 2.7613	log τ − 0.9566	log K − 6.5226	0.1116	0.899
Manured.........	Beets	Log X = 2.6138	log τ − 1.3717	log K − 5.9788	0.0829	0.949
		6-year Rotation (Potatoes, Beets, Barley, 3 Year Alfalfa)				
Non-manured.....	Potatoes	Log X = 3.1440	log τ − 1.4158	log K − 7.7333	0.0717	0.967
Manured.........	Potatoes	Log X = 3.6772	log τ − 1.4251	log K − 9.4277	0.1264	0.915
Manured.........	Beets	Log X = 2.9899	log τ − 3.0952	log K − 6.6359	0.1452	0.877

*X = amount of soil loss in pounds per acre.
τ = surface drag of the wind on the plot in pounds per acre.
K = ridge roughness equivalent in inches.

Table 3.—State and stability of dry clods on plots as affected by 39 years of cropping and manurial practices.

Rotation	Erodible fraction, <0.42 mm, per cent	Dust fraction <0.105 mm, per cent	Proportion of fine dust <0.02 mm in fraction <0.105 mm, per cent	Mechanical stability of clods >0.84 mm, per cent	Geometric mean diameter after 2nd sieving, mm
Continuous Cropping—No Manure					
Barley...	17.3	4.4	4.5	95.0	10.0
Beets....	36.3	12.2	3.3	82.7	2.50
Potatoes.	50.7	14.9	3.4	84.5	0.78
Corn....	56.3	18.2	3.8	76.9	0.68
Continuous Cropping—Manured					
Barley...	24.7	6.7	6.0	93.7	4.84
Corn....	40.6	13.8	6.5	85.1	1.45
Potatoes.	46.6	14.5	4.7	85.9	0.99
Beets—No Manure					
2-year...	37.8	12.9	3.9	80.5	1.68
3-year...	29.3	11.0	5.5	94.7	4.00
4-year...	25.8	8.8	3.4	92.8	3.15
6-year...	33.7	11.9	5.9	92.4	2.52
Beets—Manured					
2-year...	24.4	8.9	6.1	89.9	5.10
3-year...	37.5	15.5	11.6	92.5	2.12
6-year...	25.1	8.2	7.3	89.7	4.54
Potatoes—No Manure					
2-year...	52.6	15.9	4.4	83.8	0.73
3-year...	62.3	21.6	4.6	78.3	0.45
4-year...	36.9	12.2	4.9	91.3	1.28
6-year...	43.7	15.1	6.6	86.4	0.97
Potatoes—Manured					
2-year...	50.9	14.9	4.7	87.3	0.70
3-year...	53.4	15.5	5.0	92.5	0.68
6-year...	39.3	13.7	5.1	91.2	1.20

manured. No distinct difference in mechanical stability could be detected between plots in which alfalfa was grown and those without alfalfa. However, slightly increased differences in the geometric mean diameter of clods were found with alfalfa over those without alfalfa.

TOTAL NITROGEN CONTENT OF DRY CLODS

The quality of dry clods was further analyzed by determining the total nitrogen content for each of the 13 fractions from 21 plots. Reproduction of data would entail a large table. The data show that, in general, the highest total nitrogen content were clods of diameter 0.84–1.2 mm and 1.2–2.4 mm. Plots cropped continuously to potatoes showed the lowest total nitrogen content in the clods, averaging 0.044%. This value was the lowest for any cropping system. Application of manure increased the average total nitrogen content of clods to 0.070%. Differences in the nitrogen content of clods were found also in the rotation. For the non-manured potato plots, as the length of rotation increased, the total nitrogen content in all clod fractions increased progressively, averaging 0.106% for the 6-year rotation. The application of manure made further increases in the average total nitrogen content of the clods.

Plots cropped continuously to beets showed the lowest total nitrogen content in all clod sizes. The average for all clod fractions was 0.049%. As the length of rotation for the beet plots increased to 4-years the average total nitrogen content in the clods increased from 0.049% to 0.099%. However, a decrease from this maximum was obtained on the beet plot in the 6-year rotation, where the average total nitrogen content was 0.076%. With the application of manure on the beet plots there was a corresponding increase of the total nitrogen content in the clods over that on plots without manure. The application of manure for the 3-year rotation on potato plots was not as effective in increasing the total nitrogen content in clods as the three years of alfalfa (without manure) in the 6-year rotation, the two treatments giving average total nitrogen in clods of 0.083% and 0.106%, respectively. The three years of alfalfa on beet plots did not have the same effect as for the potato plots in increasing the total nitrogen content of clods. However, the application of manure on the beet plots further increased the nitrogen content of clods.

Plots continuously cropped to barley showed 0.097% average total nitrogen content for the clods, while application of manure resulted in the highest average value 0.146%, for any cropping system.

APPARENT DENSITY OF AIR-DRIED CLODS

A portion of data on the apparent density of clods for each of the 13 size fractions is given in table 4. Only the apparent densities of clods for the plots from sugar beets and potatoes in the 3- and 6-year rotations are given since those plots were used directly for measuring soil losses from wind. When comparing the density of clods >2.38 mm in diameter the size of clod has no effect on the density. For diameters <2.38 mm the data in the table show that, in general, as the diameter of clod decreased the apparent density of the clod increased. This relationship was true for all the 21 plots studied.

The data in the last column in table 4 "weighted mean apparent density" were calculated by multiplying the percentage of separate by density of clod and averaging the values thus obtained (first moment). The effect of manure in the 3-year rotation on the weighted mean apparent density of clod from potato plots was very pronounced, reducing the value from 1.85 gms/cc to 1.67. The reduction in density of clods increased the porosity from 30 to 37 per cent. A similar reduction in apparent density of clods from potato plots in a 6-year rotation was associated with application of manure. The alfalfa in the 6-year rotation in non-manured plots was more effective in reducing the weighted mean apparent density of clods (1.58 gms/cc) than the manure in the 3-year rotation (1.67 gms/cc).

The effect of manure on the apparent density of dry clod from the beet plots was not as pronounced as in the potato plots. The alfalfa effected a reduction in apparent density of 0.04 gms/cc and 0.08 gms/cc in the non-manured and manured plots, respectively.

High values of apparent density are associated with low aggregation. The clods from the field with a surface texture of loamy sand had an average apparent density of 2.31 gms/cc. By contrast an apparent density of 1.56 gms/cc was found on the manured, 6-year rotation plot cropped to beets.

MOISTURE CONTENT AT 15-ATMOSPHERES OF AIR-DRIED CLODS

Another quality of air-dried clod was reflected by the 15–A values, that is, moisture content at 15-atmosphere tension. The data on the 15–A values given in table 5 are for the clods from 3- and 6-year rotation plots after harvesting beets and potatoes. The values are used here to reflect the distribution of clay- and organic-fractions. A low degree of aggregation of particles is shown by the small 15–A values for the field with a surface texture of loamy sand. Thus, the 15–A value for fraction 0.59–0.42 mm is 1.42%, while that for the same fraction from potato plot which was manured in the 6-year rotation is 7.98%. The latter value indicates a high degree of aggregation.

The data in table 5 show that manuring of plots increased the 15–A value of clods from plots in 3-year rotation and in 6-year rotation after potatoes. This was true for the other data not included in the table. The alfalfa in the rotation gave an additional increase in the 15–A values. The 3-years of alfalfa on potato plots effected a greater increase in values than the application of 12 tons of manure every three years.

It appears from table 5 that the aggregation of particles in the fractions 1.19–0.84 mm, 0.84–0.59 mm and 0.59–0.42 mm is very small as compared to the other size fractions. This is concluded from the low values of 15–A obtained in these fractions. A wider range of 15–A values was obtained in the 3-year rotation than in the 6-year rotation. The values for the non-manured potato plots in 3-year rotation varied from 3.11% to 7.80%.

The 15–A values for the 21 plots did not show any consistent correlation with the total nitrogen content nor with the apparent density of clods.

Discussion

Tillage methods associated with the type of crop grown, kind of cropping and application of manure are important factors in the erodibility of soils to wind under the system of irrigated agriculture at the Scotts Bluff Substation. The results of soil losses from wind obtained at a particular time and place are not necessarily indicative of general conditions prevailing for any considerable length of time. To illustrate this point a measurement of soil loss after a rain shower was made on non-manured plot cropped to potatoes in the 3-year rotation already tested. The regression equation for soil eroded was $\log X = 4.2867 \log \tau - 0.6780 \log K - 10.5215$. Comparing this equation with that in table 2 for the same plot, a higher regimen of soil loss prevailed before the shower. Thus, a very small shower is capable of altering the characteristics of the immediate surface. Again, considerable dust may have been removed from the plots by spring winds occurring prior to the tests.

Many times, measurements of the effects of cropping and manurial practices fail to record the field observations on the changes in the physical properties of sandy soils. The wind-tunnel tests and the dry clod analyses have been encouraging in evaluating the changes in the physical properties of sandy soil. Although the wind tunnel apparatus is not readily available in every laboratory, the size distribution of clods may be obtained. Particularly, the apparent density of clods for each fraction may reflect the management practices. This measurement is one of the criteria used in predicting the soil losses from wind. On the first thought it may appear that the object of soil management for lessening wind erosion is to increase the apparent density of clods. The fact is that decreased apparent density of clod should be one of the aims of soil management. This is well substantiated by the example for clods from non-manured plots in the 3-year rotation in potatoes. The densities of clods smaller than 1.10 mm are nearly 2.00 gms/cc. These values, on the aver-

Table 4.—Apparent density (gms/cc) of aggregates from 3- and 6-year rotation plots cropped to potatoes and beets.

Treatment of plots	Crop	Diameter of clods, millimeters													Weighted mean apparent density
		>38.1	38.1–12.7	12.7–6.4	6.4–2.38	2.38–1.19	1.19–0.84	0.84–0.59	0.59–0.42	0.42–0.297	0.297–0.210	0.210–0.149	0.149–0.105	0.105>	
		3-year Rotation													
NM*	Potato	—	1.47	1.52	1.86	1.79	1.99	2.00	2.01	1.98	1.90	1.85	1.87	1.96	1.85
M	Potato	—	1.54	1.63	1.40	1.45	1.51	1.59	1.62	1.60	1.73	1.70	1.79	1.90	1.67
NM	Beets	1.57	1.54	1.56	1.61	1.55	1.62	1.75	1.73	1.74	1.76	1.76	1.82	1.94	1.65
M	Beets	1.54	1.58	1.54	1.49	1.46	1.46	1.55	1.57	1.70	1.67	1.71	1.83	1.92	1.64
		6-year Rotation													
NM	Potato	—	1.53	1.52	1.47	1.44	1.48	1.50	1.49	1.60	1.59	1.62	1.70	1.83	1.58
M	Potato	1.48	1.38	1.53	1.37	1.35	1.34	1.41	1.43	1.48	1.51	1.56	1.68	1.83	1.51
NM	Beets	1.53	1.48	1.55	1.51	1.34	1.52	1.62	1.69	1.71	1.74	1.76	1.79	1.89	1.61
M	Beets	1.50	1.53	1.39	1.48	1.45	1.56	1.63	1.68	1.57	1.71	1.62	1.73	1.91	1.56
		Field with a Surface Texture of Loamy Sand													
	Rye	—	—	—	—	—	—	—	2.45	2.48	2.41	2.32	2.24	2.22	2.31

*NM = non-manured.
M = manured.

Table 5.—Soil moisture, as per cent, at tension of 15-atmospheres for aggregates from 3- and 6-year rotation plots cropped to potatoes and beets.

Treatment of plots	Crop	Diameter of clods, millimeters												
		>38.1	38.1–12.7	12.7–6.4	6.4–2.38	2.38–1.19	1.19–0.84	0.84–0.59	0.59–0.42	0.42–0.297	0.297–0.210	0.210–0.149	0.149–0.105	0.105>
		3-year Rotation												
NM	Potato	—	6.23	6.14	4.65	4.62	3.11	3.13	3.24	4.28	5.03	6.00	6.72	7.80
M	Potato	—	7.75	7.46	7.49	7.56	*	6.00	6.04	6.23	6.26	6.83	*	*
NM	Beets	7.79	6.99	7.09	*	6.54	5.99	5.30	5.65	6.22	*	7.14	6.93	8.12
M	Beets	8.02	7.99	8.11	8.22	7.44	8.20	6.61	6.76	6.18	6.49	7.27	7.24	8.54
		6-year Rotation												
NM	Potato	—	8.05	8.40	8.91	8.20	8.01	8.03	7.32	7.35	7.09	7.40	7.65	8.44
M	Potato	—	8.77	8.85	9.06	9.58	9.61	8.41	7.98	8.19	8.01	8.34	7.78	8.40
NM	Beets	7.69	7.56	7.66	7.54	8.06	6.64	*	*	5.82	6.16	7.53	*	*
M	Beets	7.61	7.81	7.05	7.50	7.46	6.24	5.33	5.44	5.94	7.69	6.57	7.58	8.87
		Field with Surface Texture of Loamy Sand												
	Rye	—	—	—	—	—	—	—	1.42	1.50	2.70	3.62	1.91	5.07

* = No aggregates available for the determination.
M = Manured.
NM = Non-manured.

age, were greater than for any other plots. The wind erosion studies on potato plots indicated a soil loss of 74,500 pounds per acre. Associated with the high density values were the high percentage of aggregates less than 0.42 mm in diameter, smaller geometric mean diameter of clods, smoother surface of plots, and small amounts of surface residues.

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