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PROPERTIES OF SOIL WHICH INFLUENCE WIND EROSION: V. MECHANICAL STABILITY OF STRUCTURE

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To maintain stability against erosion by wind, the soil, it is believed, must possess a resistance to at least three commonly occurring and well-recognized groups of disintegrating agencies. These are (*a*) mechanical agents, such as tillage machinery, (*b*) the abrasive action of wind-borne soil material, and (*c*) the forces of weather. This paper deals with results of a study of the possible effects of the first two of these agencies on erodibility. One of the purposes of the investigation was to determine whether stability of a soil against any one of these agencies ensures stability against the others. The second purpose was to find why some soils exhibit a higher mechanical stability than others and how mechanical stability affects erodibility by wind.

PROCEDURE

Five soils varying widely in texture were chosen for study. Silty clay was sampled in the spring of 1949 from land sown to wheat the previous fall. All the other soils were obtained in September of 1950 soon after the fields were plowed and sown to wheat. The samples were taken to a 4-inch depth when the land was reasonably dry. A square-cornered spade was used to pick up blocks of soil with as little disturbance of structure as possible. The soils were dried at 175°F. and were placed in air-tight containers to be used as required.

The soils were tested for stability against repeated dry-sieving, against abrasion of wind-borne soil material, and against crushing and impact forces. Some or all of these stability tests were conducted on soils as obtained in the field, on natural clods, and on erodible fractions. The soils and their component parts were tested for stability both before and after wetting with water and drying at 175°F. All tests were at least in duplicate.

Stability against sieving

A rotary sieve (2) was used to obtain from the dry soil all aggregates greater than 0.42 mm. in diameter. Of this fraction, 2,000 gm. was again passed through the sieve two to four times. Stability was estimated from the weight of the dry aggregates that did not pass through the 0.42-mm. sieve. The diameter of 0.42 mm. marks an approximate dividing line between erodible and nonerodible fractions under the most common erosive velocity of the wind.

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Stability against abrasion of wind-borne soil material

A wind tunnel used regularly in this work was operated to supply wind of any desired drag velocity, V_*. The material which served as an abrader was obtained from the portion of the soil that passed through a 0.42-mm. sieve. The abrader was placed in a tray 5 feet long, 8 inches wide, and 2 inches deep, with no end walls. The tray was placed parallel to the direction of the wind and immediately on the windward of another similar tray containing the soil or soil fraction to be abraded. The amount of abrader that passed over the soil was determined from the difference in the weight of the tray containing the abrader before and after exposure to the wind minus the amount of abrader that by-passed the exposed soil at the half-way mark. The amount of soil abraded was determined by the loss in weight of the soil material in the second tray. If the soil being abraded had not too rough a surface, the tray containing the abrader was removed after the test, and the wind alone was applied until all or nearly all of the abrader lodged on the soil surface was removed. The soil was then weighed. If relatively large soil clods were exposed to abrasion, these were picked up by hand and weighed.

On soils with extremely rough surfaces and extremely wide ranges of fraction sizes, no method was found that would accurately measure the amount of abrader that passed over. Because of this difficulty, another series of tests was conducted in which individual clods and small blocks of soil were used. These were placed in a 5-foot tray on the leeward of the tray containing the abrader. Baffles were placed on the floor of this tray to the lee of the clod or block to trap fragments of soil material broken off by impacts of the abrader. The amount abraded was determined by weighing the clod or block before and after exposure and adding to this difference the weight of the soil fragments greater than 0.42 mm. that were broken off the clod or block and lodged at the bottom of the tray. The amount of soil fragments greater than 0.42 mm. was determined by sieving.

Blocks of soil were prepared as follows: A piece of moderately stiff waxed paper 8 inches long and $2\frac{1}{2}$ inches wide was rolled into a cylindrical sleeve 2 inches in diameter and $2\frac{1}{2}$ inches high. Thin wire was wrapped around the outside. The sleeve was placed vertically on a small flat plate and filled with soil. About 1 inch of water was sprayed over the surface with a hose. The plate, sleeve, and soil were then transferred to an oven and thoroughly dried at 175°F. The sleeve was then removed. In every case the soil block held together without crumbling.

Stability against collision

The soil obtained in the field and dried at 175° F. was sieved to obtain the desired sizes of aggregates. Two classes of soil aggregates were obtained: (*a*) all of those retained on the 0.42-mm. sieve and (*b*) those that passed the $\frac{3}{8}$-inch square openings and were retained on the $\frac{3}{8}$-inch round. Of each material, 500 gm. was placed in a metal cylinder 1 yard long, 4 inches in diameter, equipped with a tight lid. The cylinder was inverted end-over-end 20 times. The aggregates were allowed to fall and strike the bottom on each inversion. The soil material was then subjected to rotary sieving. Stability was expressed in terms of percentage of the original weight of the soil aggregates retained on the 0.42-mm. square openings of the sieve.

Stability against crushing

A method adapted by Martinson and Olmstead (5) was used on dry aggregates that passed through a sieve with $\frac{3}{8}$-inch square openings and retained on a sieve with $\frac{3}{8}$-inch round opeings. Stability against crushing was expressed in terms of ounces of force required to crush the aggregate per gram.

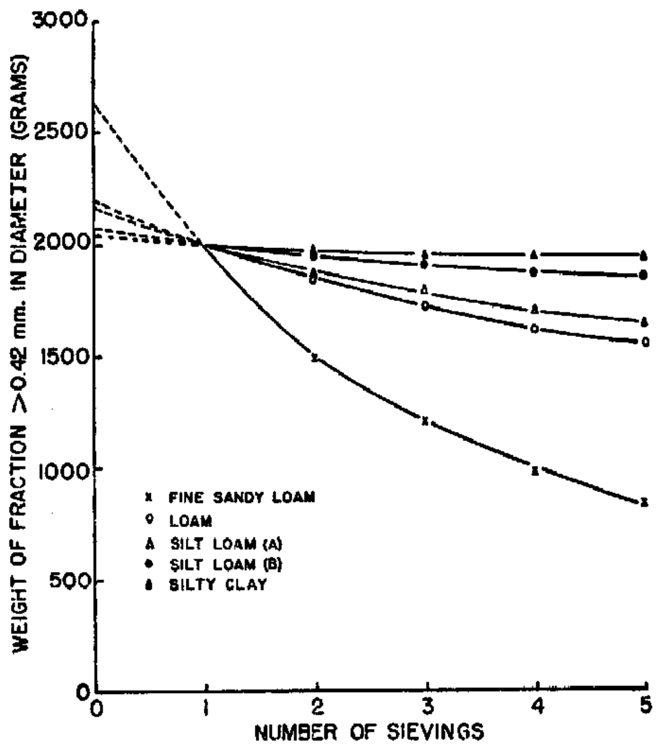

FIG. 1. LOSS IN WEIGHT OF DRY AGGREGATES DUE TO REPEATED ROTARY SIEVINGS

RESULTS

Stability against sieving, crushing, and collision in relation to erodibility by wind

Dry aggregates obtained from different soils by sieving broke down in varying degrees under subsequent repeated sievings. The weight of the aggregates greater than 0.42 mm. in diameter plotted against the number of sievings is shown in figure 1. By projecting the plotted curves to the axis of the ordinate (represented by broken lines) it was possible to estimate the weight of these aggregates contained in each soil before the initial sieving. Based on this weight, the percentage of aggregate breakdown due to each sieving could be determined.

Stability of the dry aggregates or clods against sieving varied directly with the fineness of soil texture (table 1). Thus, silty clay, the finest textured soil used in these tests, had dry aggregates that were most resistant to breakdown by sieving. It was followed in order by silt loam B, silt loam A, loam, and fine sandy loam. The greatest breakdown of aggregates in all soils occurred during the first sieving. Subsequent sievings broke the aggregates less and less.

The increase in erodibility caused by sieving varied inversely with the stability of the nonerodible aggregates against sieving (fig. 2, left side). Thus, in the soils examined, the increase in erosion caused by one sieving was 2.18, 0.43, 0.36, 0.06, and 0.01 tons per acre and the decrease in the weight of dry aggregates greater than 0.42 mm. caused by seiving was 24.3, 9.2, 7.5, 2.0 and 3.9 per cent

TABLE 1

Mechanical composition of soils studied

SOIL	SAND	COARSE SILT	FINE SILT	CLAY
	>0.05 mm.	0.05–0.02 mm.	0.02–0.002 mm.	<0.002 mm.
	%	%	%	%
Fine sandy loam	52.3	35.0	8.6	4.1
Loam	44.8	31.1	13.9	10.2
Silt loam A	29.8	40.5	17.8	11.9
Silt loam B	18.4	29.5	27.9	24.2
Silty clay	12.0	17.8	29.0	41.2

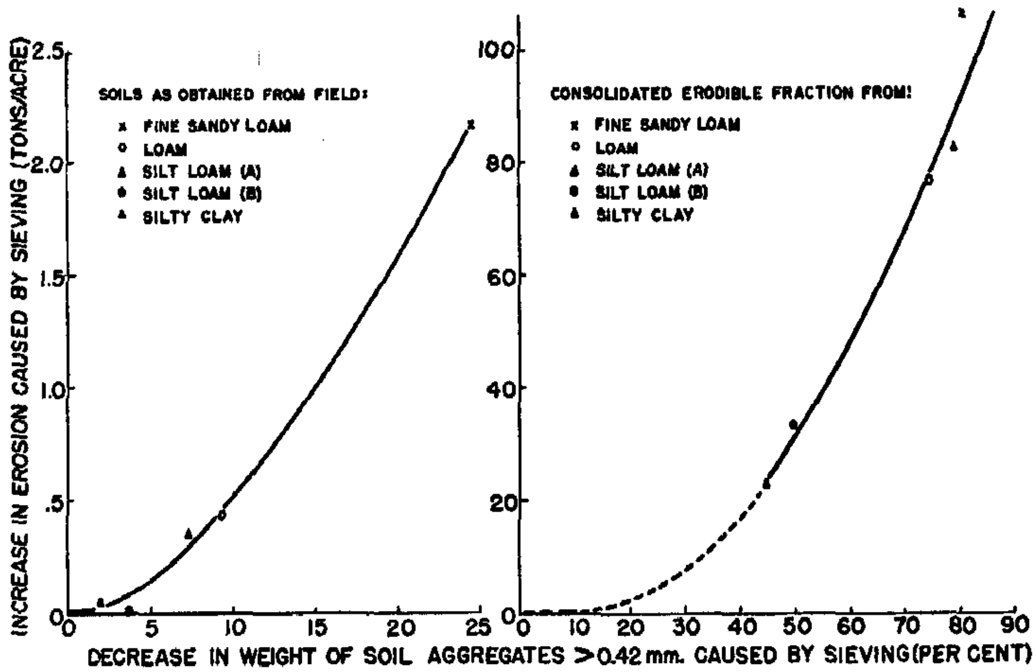

FIG. 2. RELATIONSHIP BETWEEN INCREASED ERODIBILITY AND DECREASED WEIGHT OF NONERODIBLE AGGREGATES CAUSED BY ONE ROTARY SIEVING

Drag velocity 61.5 cm. per second. Soil was exposed to wind until erosion ceased.

respectively. One reversal in the order occurred in the last two fine textured soils. The reversal was apparently due to the fact that the amount of erosion on these soils was too small to be measured accurately.

To establish more conclusively the possible relationship between erodibility and breakdown by sieving, it was necessary to deal with a highly erodible fraction of each soil. A fraction passing through 0.42-mm. sieve openings for each soil was consolidated, in a tray 5 feet long and 8 inches wide, by wetting with a spray of water and drying. The erodibility of this fraction was determined before and after sieving. As before, the data on the right side of figure 2 show that the increase in erodibility caused by sieving varies inversely as the stability of the nonerodible aggregates against sieving. The relationship is logarithmic.

Spraying and subsequent drying of the soil or of the erodible fraction of the soil produced a weakly consolidated body. The degree of breakdown by sieving of this body of soil particles that originally passed through the 0.42-mm. sieve openings is shown in figure 3. A comparison of these results with those of figure 1 shows two striking differences: First, the clods, such as those found in a newly plowed field, were much more resistant to breakdown by sieving than was the

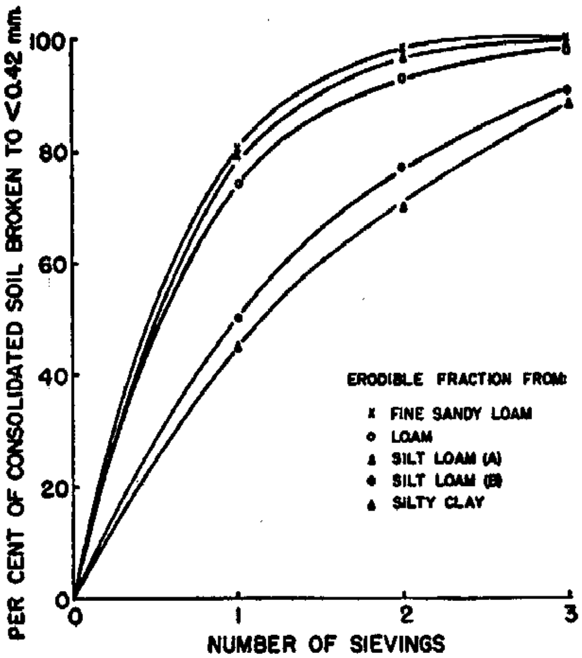

FIG. 3. LOSS IN WEIGHT OF WEAKLY CONSOLIDATED ERODIBLE SOIL FRACTION DUE TO REPEATED ROTARY SIEVINGS

soil body composed of erodible particles consolidated by wetting and subsequent drying. Second, stability of the clods against sieving was not of the same order as stability of blocks of weakly consolidated erodible fractions derived from the same soils. Thus, in contrast to the dry aggregates, the order of breakdown of the weakly consolidated soil body, from lowest to highest was silt loam A, silt loam B, loam, silty clay, and fine sandy loam. Resistance of dry clods to sieving was governed by soil texture; that of the consolidated soil body was not. It is interesting to note that the consolidated body of the coarsest and the finest textured soils showed the lowest resistance to sieving.

An attempt was made to find the cause or causes for differences in the mechanical stability of the consolidated soil body. It was found that the greater the resistance to mechanical breakdown by sieving in a dry state (fig. 3), the greater was the degree of dispersion of the soil in water into fractions smaller than 0.02

mm. in diameter (table 2). Thus, silt loam A, which showed the highest mechanical stability, also showed the highest degree of dispersion in water, and fine sandy loam and silty clay, which showed the lowest mechanical stability in a dry state, also showed the lowest degree of dispersion in water. A previous study (6) showed that the greatest cohesive strength in a dry state after wetting is exhibited by

TABLE 2

Air-dry and water-stable aggregate structure of soils studied

SOIL	MEDIUM	AGGREGATE DISTRIBUTION BY WEIGHT							
		>6.4 mm.	6.4–0.84 mm.	0.84–0.42 mm.	<0.42 mm.	0.42–0.05 mm.	0.05–0.02 mm.	0.02–0.005 mm.	<0.005 mm.
		%	%	%	%	%	%	%	%
Fine sandy loam	Air	17.7	16.9	3.0	62.4	—	—	—	—
	Water	0	0.1	1.3	—	53.8	40.0	3.9	0.9
Loam	Air	47.3	18.2	1.5	33.0	—	—	—	—
	Water	0	0.2	2.1	—	60.0	30.7	5.1	1.9
Silt loam A	Air	41.5	21.0	6.2	31.3	—	—	—	—
	Water	0	0.2	6.5	—	43.8	35.2	11.3	3.0
Silt loam B	Air	51.3	34.9	4.3	9.5	—	—	—	—
	Water	0	1.1	10.3	—	49.6	25.6	10.6	2.8
Silty clay	Air	28.0	21.5	16.2	34.3	—	—	—	—
	Water	0	0.9	11.8	—	75.9	5.2	4.1	2.1

TABLE 3

Crushing strength of dry soil aggregates and their susceptibility to breakdown by collision and sieving

SOIL	CRUSHING STRENGTH OF STANDARD SIZE AGGREGATES*	WEIGHT OF STANDARD SIZE AGGREGATES BROKEN DOWN TO <0.42 MM.			WEIGHT OF ALL AGGREGATES >0.84 MM. BROKEN DOWN TO <0.42 MM.		
		By collision and sieving	By sieving only	By collision only	By collision and sieving	By sieving only	By collision only
	oz./gm.	%	%	%	%	%	%
Fine sandy loam	24.2	67.7	12.4	55.3	60.1	10.3	49.8
Loam	55.2	38.1	5.4	32.7	38.4	7.0	31.4
Silt loam A	87.4	22.4	2.6	19.8	21.5	3.9	17.6
Silt loam B	226.0	7.2	0.5	6.7	6.2	0.8	5.5
Silty clay	375.0	2.3	0.06	2.2	5.4	0.6	4.9

*Standard size is that passing through a 3/8-inch square opening and retained on a 3/8-inch round. Averages of 40 determinations.

dispersed clay, and the least, by quartz particles 0.02 to 0.50 mm. in diameter. It showed further that blocks of quartz particles larger than 0.05 mm. do not exhibit a measurable degree of cohesion. Obviously, then, the amount of dispersed fine silt and clay when the soil is wet is at least partly associated with a mechanical stability of the soil body when it is dried, and consequently with its increased resistance to erosion by wind.

Additional tests were conducted to see whether resistance of soil aggregates to crushing, collision, and sieving varies with these mechanical treatments. Table 3 shows that resistance to crushing varied directly with the fineness of soil texture. Resistance to breakdown by collision and by sieving varied in the same order. Apparently, any of the methods can be used as a measure of the relative mechanical stability of these dry soil aggregates.

Stability against abrasion by wind-blown soil material

It has been observed in the field that, once soil movement has been initiated by the wind, the intensity of the movement is accelerated in large measure by the degree of disintegration of the soil by abrasion caused by the bouncing soil

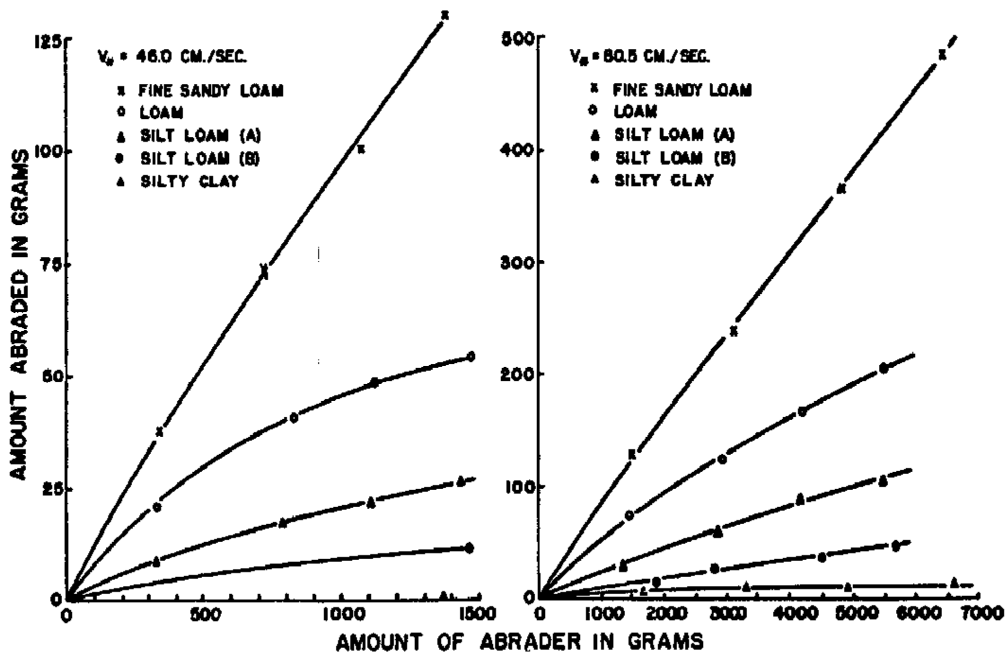

Fig. 4. Loss in Weight of Dry Clods 25 to 50 mm. in Diameter Subjected to Abrasion by Drifting Soil Composed of Particles and Grains Less Than 0.42 mm. in Diameter

fractions (4). A study of this phenomenon was made in a wind tunnel under controlled conditions of wind and soil. Figure 4 shows the losses in weight of clods of different soils subjected to abrasion by drifting of erodible particles. Stability of clods against abrasion by wind-blown soil material, as against sieving, varied directly with the fineness of soil texture. Thus, under a drag velocity of 46.0 cm. per second, only a trace (less than 5 gm.) of silty clay was abraded by 1,500 gm. of the wind-blown material. This was followed in order by silt loam B, 12 gm. abraded; silt loam A, 26 gm.; loam, 52 gm.; and fine sandy loam, 140 gm. The same order of stability against abrasion was exhibited under a drag velocity of 80.5 cm. per second. Comparison of figure 4 with figure 2 shows that the increase in the amount of erosion caused by sieving and the loss in weight of clods due to abrasion of wind-blow soil material varied more or less proportionately with each other. Obviously, stability of the dry soil aggregates against sieving can be used as a relative measure of stability against abrasion by wind-blow soil material.

The dry soil aggregates constitute only a part of the total soil. It was necessary, therefore, to carry the experiments further to determine the mechanical stability of the fine, erodible fraction also. The fine soil fraction was that which passed through 0.42-mm. sieve openings. It was consolidated by spraying with 1 inch of water followed by thorough drying at 175°F. In all soils the surface was smooth. Consequently, in no case was the abrader trapped on the surface.

Figure 5 indicates that the rate of abrasion of the consolidated fine fraction varied widely in a different soils. Moreover, the rate of abrasion usually varied with duration of exposure. It was evident that both the condition of the surface

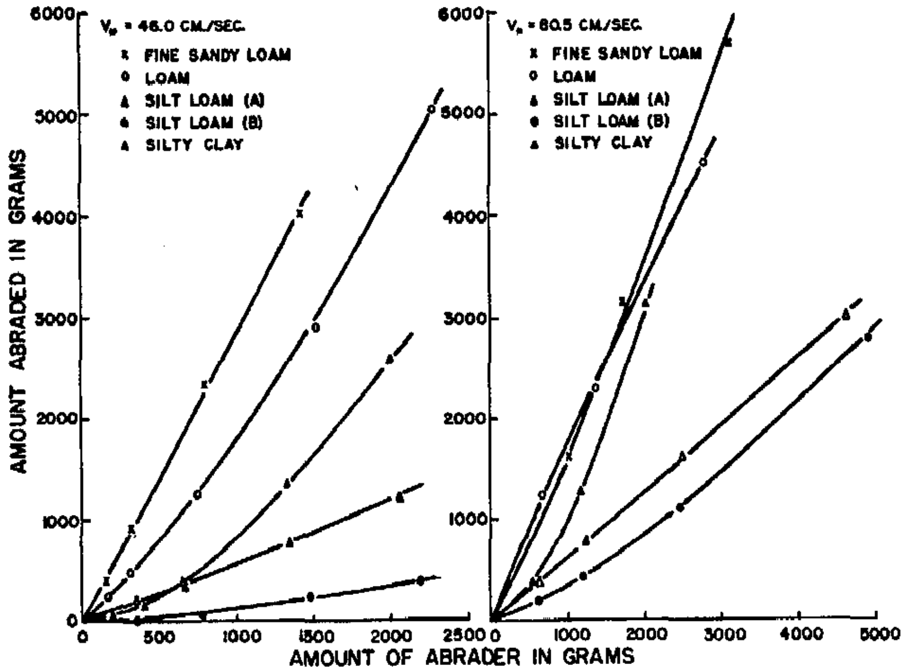

Fig. 5. Loss in Weight of Consolidated Erodible Soil Fraction Subjected to Abrasion by Drifting Soil Composed of Particles and Grains Not More Than 0.42 mm. in Diameter

roughness and that of the soil below the surface were repsonsible for the differences in the rate of abrasion. Spraying to simulate rain caused the formation of a thin surface crust, usually not exceeding $\frac{1}{16}$ inch in thickness. The nature of this crust and its relation to erosion by wind can be perhaps best interpreted from figure 6.

On fine sandy loam virtually no surface crust formed. Consequently, the rate of abrasion was more or less constant from the beginning of exposure to the end. On all other soils, because of the presence of the crust, the rate of abrasion on the whole was least at the beginning. As the crust was worn through, the rate increased. The rate of abrasion of the soil below the crust was highest for fine sandy loam. This was followed in order by silty clay, loam, silt loam B, and silt loam A. This order is the same as the order of susceptibility of these soil materials to breakdown by sieving (fig. 2, right side) and inversely as the order of degree of dispersion in water (table 2).

Mechanical stability, so far, has been determined independently for the nonerodible aggregates, for the consolidated erodible fractions, and for the surface crust. It is evident from the data presented that stability of the dry soil aggregates against sieving and abrasion is not of the same magnitude nor is it variable in the same order as stability of the surface crust and as stability of the finer erodible fractions consolidated by a rain. Further experiments were conducted to verify these results in another way. Small blocks of soil were prepared as outlined under "Procedure" and were exposed to abrasion by dune sand. As

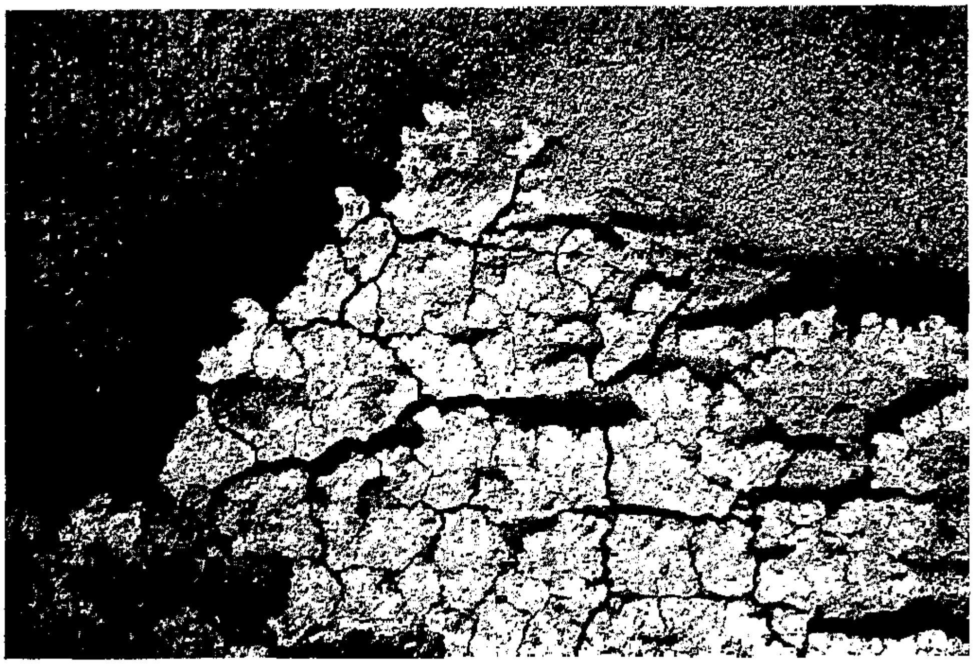

FIG. 6. REMNANTS OF A SURFACE CRUST ON SILTY CLAY AFTER EXPOSURE TO ABRASION BY HIGHLY ERODIBLE SILTY CLAY PARTICLES FOR 5 MINUTES UNDER A DRAG VELOCITY OF 80.5 CM. PER SECOND

The soil was completely stable under the same wind without the abrader. Wind direction left to right. One half actual size.

before, the rate of abrasion of consolidated blocks of erodible fraction was highest on fine sandy loam, followed in order by silty clay, loam, silt loam B, and silt loam A (fig. 7). This order varies inversely as the degree of dispersion of these soils in water into particles smaller than 0.02 mm. in diameter. The rate of abrasion of natural clods, on the other hand, varied directly as the fineness of soil texture. The rate of abrasion of clods was much less than that of the rest of the soil body consolidated by a rain. The rate of the nonerodible aggregates was, on the average, about one-fiftieth of the rate of abrasion of the rest of the consolidated soil body. It is evident that the discrete soil aggregates are much more compact than the rest of the soil body.

The rate of abrasion of consolidated blocks of field soil was somewhere between the rate of abrasion of the discrete soil aggregates and that of the consolidated soil mass (fig. 7). This rate was not the average of the two, however, because the proportion of the erodible, semierodible, and nonerodible fractions in each soil in a dry state was not the same (table 2).

The exposure of blocks of soil to abrasion gave further opportunity to study the nature of the surface crust and its relation to erosion by sand. Because the rate of abrasion was not uniform with height, being most intense at about 1 inch height, the cylindrical blocks were laid on their sides and at right angles to the direction of the wind for exposure to abrasion by dune sand. This placement facilitated an equal amount of abrasion along any vertical axis, from the tip of the cylindrical block where the water spray struck the surface to the bottom.

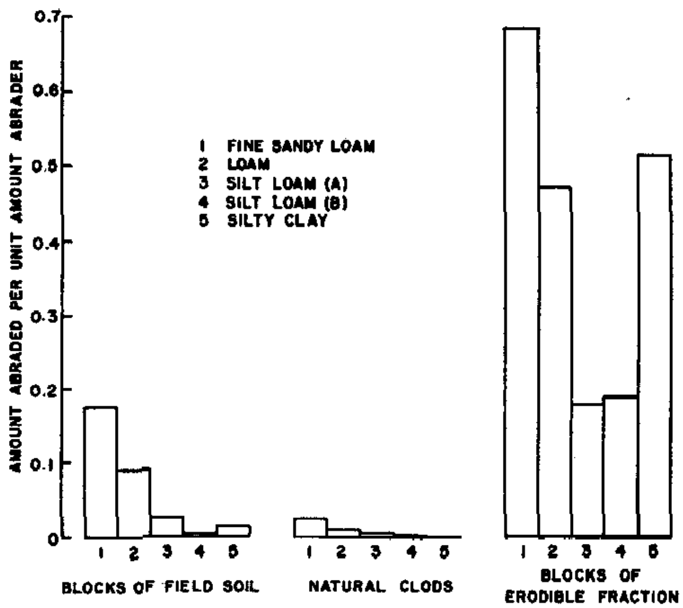

FIG. 7. LOSS IN WEIGHT OF WEAKLY CONSOLIDATED SOIL BLOCKS AND OF NATURAL CLODS SUBJECTED TO ABRASION BY DUNE SAND

Blocks of soil were consolidated by placing soil in a cylindrical container with a porous bottom, thoroughly wetting with a spray of water, then drying at 175°F.

The amount of abrasion was determined by weighing the block before and after exposure. The amount and nature of the abrasion on blocks returned to their vertical position are shown in figure 8. In every soil, except the fine sandy loam, a thin body of soil at the very top is shown protruding into the direction of the wind. This body is the surface crust. The crust was apparently more resistant to abrasion than the soil underneath. As judged by the length of the protrusion, the crusts of silt loam A and silt loam B were most resistant to abrasion, followed in order by those of loam and silty clay. The order of magnitude and stability to abrasion of the surface crust varied directly as the quantity of discrete soil particles less than 0.02 mm. in diameter contained by the soil when immersed in water. The dry crust was much less compact and less mechanically stable than the dry aggregates, but more compact and stable than the rest of the cemented soil body.

Figure 9 shows further that the rate of abrasion of blocks of any soil or of any of the two fractions of the soil varies directly and proportionately with the increase in the amount of erosion due to breakdown of structure by rotary sieving. Mechanical stability of soil structure, as determined by sieving, can serve, therefore, as a measure of the relative resistance of the soil to abrasion by windborne soil particles.

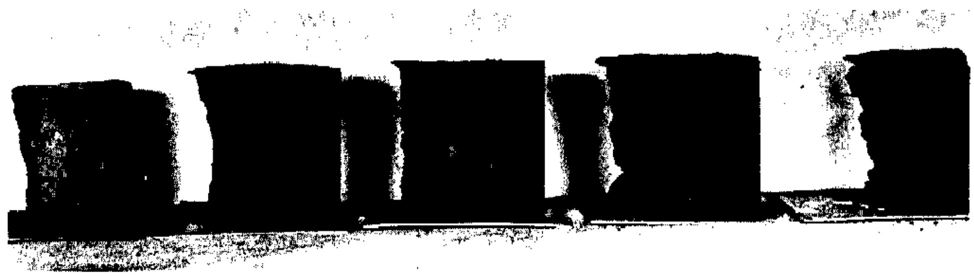

FIG. 8. ABRASION BY DUNE SAND OF ORIGINALLY CYLINDRICAL BLOCKS OF CONSOLIDATED SOIL FRACTION THAT PASSED THROUGH 0.42-MM. SIEVE OPENINGS

The blocks were laid on their sides and exposed to abrasion. Soil materials, left to right, are fine sandy loam, loam, silt loam A, silt loam B, and silty clay. Wind direction left to right. Note the protrusion of the surface crust. One fourth actual diameter.

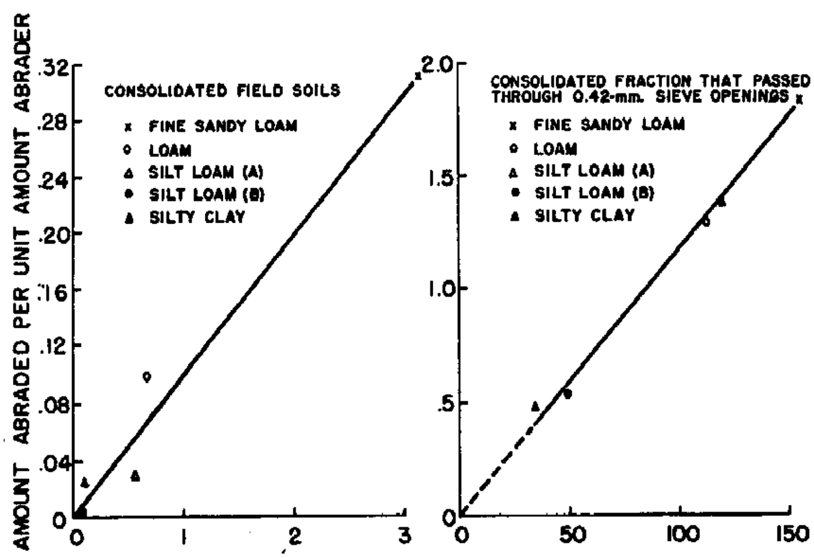

FIG. 9. RELATION BETWEEN SUSCEPTIBILITY OF SOIL TO ABRASION BY IMPACTS OF ERODING SOIL AND INCREASE IN AMOUNT OF EROSION CAUSED BY ONE ROTARY SIEVING

Drag velocity of erosive wind 80.5 cm. per second. Length of abraded soil surface 5 feet.

DISCUSSION AND CONCLUSIONS

Wetting followed by drying was found to produce a more or less consolidated soil body such as usually exists in the field. This body is not homogeneous. It is composed of various types of structural units cemented together in various degrees. The strength of cementation, and consequently the mechanical stability, varies greatly in different soils and in different structural units of the soil. Two types of soil cements seem to be responsible for consolidation of the soil into different structural units: (*a*) water-insoluble, and (*b*) water-soluble or more commonly water-dispersible. These cements appear to be responsible for the following types of soil aggregates with distinct degrees of mechanical stability and erodibility by wind:

Water-stable aggregates. These primary aggregates, which seldom exceed 1 mm. in diameter in cultivated soils, are held together by water-insoluble cements composed of clay particles and irreversible or slowly reversible inorganic and organic colloids (1, p. 138). The water-stable granules possess high mechanical stability and stability against the disintegrating forces of the weather. Without appreciable quantities of other cementing materials in the soil, the water-stable granules tend to remain as discrete units, giving the soil a characteristic mellow structure commonly designated as "good tilth." In some soils these granules are large enough to withstand the erosive force of high wind; in others they are not.

Dry aggregates or clods. These secondary aggregates have a wide range of size and mechanical stability, depending on soil class, depth, and tillage treatment. They are held together in a dry state especially by water-dispersible cements acting under pressure and time. These cements are composed mainly of water-dispersible soil particles smaller than 0.02 mm. in diameter. The greater the depth and the longer the time, the more compact and mechanically stable the secondary aggregates become when dry. Many of these aggregates when brought up near the surface maintain their identity for some time even after repeated wetting and drying in the field.

Whole soil body. A single rain often induces dispersion of a sufficient amount of silt and clay smaller than 0.02 mm. in diameter to form a more or less consolidated soil body when it dried. The strength with which the primary and the secondary structural units are consolidated in a dry state varies with depth, as follows:

Because of impacts of rain, the soil material at the surface becomes more dispersed than the soil below. On drying, the highly dispersed soil forms a thin surface crust, which is more compact and mechanically stable than some parts of the soil below. The crust seldom exceeds $\frac{1}{16}$ inch in thickness.

A rain, or a series of rains, often carries some of the finer dispersed constituents downward, leaving the coarser particles, such as sand or water-stable aggregates at the top. Some of these coarser particles remain loose on the surface and often lead to serious erosion by wind even before the drying of the surface has become apparent.

The strength of cementation between the secondary aggregates in a dry state after the soil has been wetted increases with depth, apparently because of increase in pressure exerted by the weight of the soil. The strength of cementation between the secondary aggregates is, on the average, much less than that within these aggregates.

The different structural units of the soil possess great differences in mechanical stability. The order of mechanical stability from highest to lowest varies as the following structural units in a dry state: (*a*) water-stable aggregates, (*b*) secondary aggregates or clods, (*c*) surface crust, and (*d*) consolidated material between the secondary aggregates. The last at some depth below the surface may possess a mechanical stability that approaches or even exceeds that of the surface crust.

Mechanical stability of the secondary aggregates or clods was found to vary directly as the fineness of soil texture. Mechanical stability of the consolidated soil body, on the other hand, was found to vary more closely as the amount of silt and clay, especially of the size less than 0.02 mm., dispersed when the soil is immersed in water.

It is evident from this study that mechanical stability of soil structure as a whole has a profound influence on erodibility by wind. Mechanical stability tends to prevent wind erosion by resisting the breakdown of nonerodible fractions into smaller erodible particles. The breakdown in the field is caused by two groups of commonly occurring agents: (*a*) mechanical agents, such as tillage machinery, and (*b*) the abrasive action of wind-borne soil material. The former agents enhance the intensity of the latter, but absence of the former does not preclude presence of the latter.

Mechanical stability as determined by dry-sieving, by crushing, or by collision varies in direct proportion to the resistance of the soil to abrasion by impacts of wind-blown soil material. Mechanical stability as determined in the laboratory apparently can be used as a measure of the relative resistance of a dry soil to breakdown by mechanical agents, such as tillage machinery, and to breakdown by the abrasive action of soil material that is transported by wind along the surface of the ground.

Obviously, results of dry-sieving are dependent to some degree on the state of structure and to some degree on the stability of structure. Whether the relative significance of the state and stability of structure can be properly assessed by dry-sieving is difficult to determine. This is because the relative importance of state and stability of dry structure varies in accordance with the area of the field, the roughness of the surface, and many other factors. Thus, for a small area the amount of abrasion from erosion, once it is initiated, is small. The state of structure over such an area determines whether the soil is to drift with the wind and, if so, how much. For a large field, on the other hand, the stability of structure is the more important factor. In such a case, if the soil lacks mechanical stability, the presence of even a small amount of loose erodible material on the surface is usually sufficient for substantial disintegration of the consolidated portion of the soil by abrasion from this erodible material and for consequent intense erosion over the whole field (4).

SUMMARY

Mechanical stability varied greatly for the different structural units of the soil. It was highest for the water-stable aggregates, followed in order by that of the secondary aggregates or clods, the surface crust, and the weakly consolidated material between the secondary aggregates.

Mechanical stability of soil clods varied directly with the fineness of soil texture.

Mechanical stability of dry structural units other than the primary and the secondary aggregates, varied directly with the amount of dispersed silt and clay (particles smaller than 0.02 mm. in diameter) produced by the soil on immersion in water.

Mechanical stability as determined by sieving, by crushing, or by collision varied in direct proportion to the resistance to abrasion by impacts of wind-blown soil material.

The amount of breakdown of the nonerodible fractions caused by sieving and

the consequent increase in the amount of wind erosion varied in direct proportion with each other. Mechanical stability of the various structural units as a whole had a profound influence on erodibility by wind.

The state and stability of the dry soil structure was determined by repeated sieving. The relative significance of the state and stability of structure in relation to wind erosion could not be assessed because the significance of each varies under different conditions. The best recognized of these conditions is the area of the field.

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