The Effect of Synthetic Conditioners on Some Phases of Soil Structure and Erodibility by Wind

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Reprinted from SOIL SCIENCE SOCIETY OF AMERICA PROCEEDINGS
Vol. 18, No. 4, October 1954

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ABSTRACT

Beginning in 1951, a series of experiments was initiated on several soils for the primary purpose of determining the value of VAMA (a modified vinyl acetate maleic acid compound), and HPAN (a hydrolized polyacrylonitrile), for controlling erosion of soil by wind.

VAMA increased substantially the proportion of water-stable aggregates in all soils tested and decreased the proportion of fine water-dispersible particles < 0.02 mm. in diameter. From this standpoint VAMA may be considered a very effective soil aggregating agent. However, the great majority of the water-stable aggregates formed by VAMA were of the size erodible by wind.

VAMA applied to the surface of the ground, or mixed with the soil, generally increased the erodibility by wind. The soils treated with VAMA were loose and friable and had a granular surface. The untreated soils were more or less cemented together and had a distinctly developed surface crust. The crust was resistant to wind erosion despite its unfavorable characteristics otherwise.

VAMA was beneficial for producing good soil tilth and for increasing soil permeability. Both of these characteristics tend to reduce erosion by water and increase crop yields.

VAMA was incorporated into the soil more conveniently as dust than as spray.

HPAN applied on top of the ground was ineffective in controlling erosion of soil by wind as early as one week after the application. Erosion, in fact, was increased in some cases due to the application of HPAN.

In June, 1951, a series of experiments was initiated on several soils from central and western Kansas to determine the value of a modified vinyl acetate maleic acid compound in controlling erosion of soil by wind. This product was obtained in a dry, powdered form. Henceforth in this paper it will be referred to as VAMA.

Another series of experiments was initiated for the same purpose in June 1952, using VAMA and HPAN (hydrolized polyacrylonitrile) at higher rates of application than those of the first series.

The soils used were obtained from cultivated fields. All but one of these soils were representative of their type. The exception was the soil material deposited against a roadside by wind in an area represented by Ulysses silty clay loam. For convenience, this soil material will be called Ulysses silty clay loam drift.

Procedure

SERIES OF JUNE 1951

Experiment 1.—Samples of soil weighing 7,500 gr. (oven dry basis) were placed in porous bottomed trays 5 feet long, 8 inches wide, and 1¼ inches deep. The bottoms were composed of brass wire gauze with openings approximately 0.1 mm. in diameter. VAMA in various amounts was dissolved in 1,200 cc. of water and sprayed on dry soil. The amounts were equal to 0, 0.025, 0.1, and 0.2% of the weight of the soil. The soil was worked immediately with a trowel, simulating 4 diskings. Any large clods were broken up. The trays of soil were placed in the field and covered with ¼-inch screen to prevent any erosion that might otherwise occur.

Experiment 2.—Same as experiment 1, except that soils were not worked after the spray was applied to the surface. The rates of application were 0, 14, 67, and 260 pounds per acre.

Experiment 3.—VAMA was applied to field plots 10 feet square on Geary silty clay loam. VAMA was applied on the surface of the ground in two ways—as dust and as spray. After the application, the land was spaded once, plowed to 6-inch depth and spaded again. The land was plowed again one week later and sown to clover.

SERIES OF 1952–1953

Experiment 1.—Same as experiment 1 of the 1951 series with two exceptions: *(1)* VAMA was applied as dust to the soil at about its lower plastic limit and mixed thoroughly, and *(2)* the amounts of VAMA were equal to 0, 0.1, 0.5, and 1.0% of the weight of soil. This experiment was initiated in June 1952.

Experiment 2. (1952)—VAMA was dusted uniformly on the surface in June, 1952, and the surface was sprayed with water equal to about 0.1 inch of rain. The rates of application were 0, 130, 260, and 1,300 pounds per acre. In all other respects the procedure was the same as experiment 1 of 1951.

Experiment 2. (1953)—HPAN was dusted uniformly on the surface in March 1953 and the surface was sprayed with 0.1 inch of water. The rates of application was 0, 120, 1,200 pounds per acre. In all other respects the procedure was the same as experiment 1 of 1951.

METHODS OF ANALYSIS

Measurements of size-distribution of water-stable and dry aggregates, and of erodibility of soils by wind were made in the fall and in the spring of each year. Measurements of soil permeability and moisture-holding capacity were made at irregular intervals.

The size-distribution of the water-stable aggregates was determined by the method of Yoder (8). The size-distribution of dry aggregates was determined by the method of Chepil and Bisal (1), permeability by the method of Fireman (5), and moisture-holding capacity by the method of Richards (7). Measurements of soil erodibility were made in a laboratory wind tunnel (9). The soils in the trays were brought in from the field in an undisturbed condition and were exposed to wind until removal ceased. The soils were then mixed with a trowel to simulate tillage, and again exposed to wind until removal ceased. The drag velocity of the wind was 1.8 miles per hour. This is equivalent to a velocity of from 40 to 60 miles per hour at a 60-foot height. The soils were returned to the field after the tests were completed.

All determinations were conducted in duplicate. For the reader's convenience, only the average results are presented in this report. Analyses of variance for different physical conditions and erodibility between treated and untreated soils were made. To conserve space, detailed results of these analyses are not included in the tables, but the degree of significance in differences between treatments are mentioned in the body of the report.

Results

Solutions of VAMA were difficult to prepare. If dust was added to water too fast, lumps formed and were very difficult to dissolve. It was decided that in subsequent use VAMA, if obtained as dust, should be added to soil in its original form.

[1]Contribution 490, Department of Agronomy, Kansas Agr. Exp. Sta., Manhattan, Kans., and the B.P.I.S.A.E., U. S. Department of Agriculture. Cooperative investigations in the mechanics of wind erosion. Acknowledgment is due G. W. Wright for assistance in determining permeability and moisture holding capacity of soils. Presented before joint meeting of Div. I and Div. III, Soil Science Society of America, Dallas, Tex., Nov. 19, 1953. Rec. for publication Dec. 16, 1953.

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Table 1.—The effect of VAMA on the size distribution of water-stable aggregates.

Soil type	Proportion of VAMA	Water-stable aggregates: In fall, 4 mo. after treatment >0.84 mm.	0.84–0.02 mm.	<0.02 mm.	In spring, 9 mo. after treatment >0.84 mm.	0.84–0.02 mm.	<0.02 mm.
	%	%	%	%	%	%	%
Series of 1951, Experiment 1							
Pratt fine sandy loam	0	0.2	97.8	2.0	0.2	95.4	4.4
	0.025	2.7	96.0	1.3	0.8	96.6	2.6
	0.1	3.8	94.9	1.3	2.4	95.5	2.1
	0.2	9.4	89.9	0.7	3.9	92.9	3.2
Wabash silt loam	0	1.6	80.3	18.1	1.6	83.3	15.1
	0.025	11.4	73.1	15.5	4.7	82.9	12.4
	0.1	34.1	61.8	4.1	11.0	82.7	6.3
	0.2	44.3	54.7	1.0	11.7	84.9	3.4
Sutphen clay	0	1.8	83.2	15.0	1.2	87.4	11.4
	0.025	2.8	81.2	16.0	2.5	88.1	9.4
	0.1	9.4	79.1	11.5	4.6	86.0	9.4
	0.2	18.4	69.6	12.0	8.7	84.9	6.4
Series of 1952, Experiment 1							
		In fall, 4 mo. after treatment			In fall, 15 mo. after treatment		
Lancaster fine sandy loam	0	2.0	89.0	9.0	1.1	90.7	8.2
	0.1	11.5	80.5	8.0	2.2	91.5	6.3
	0.5	32.8	64.8	2.4	13.9	82.3	3.8
	1.0	32.9	65.2	1.9	18.6	78.5	2.9
Ulysses silty clay loam drift	0	1.0	93.0	6.0	0.8	92.6	6.6
	0.1	3.9	92.1	4.0	1.6	93.5	4.9
	0.5	12.7	86.4	0.9	3.3	93.7	3.0
	1.0	27.7	71.3	1.0	8.1	90.1	1.8
Sutphen clay	0	1.3	92.7	6.0	0.7	91.9	7.4
	0.1	7.0	90.6	2.4	0.8	93.6	5.6
	0.5	13.7	86.3	T	3.8	92.9	3.3
	1.0	31.2	68.0	0.8	8.6	89.5	1.9

Table 2.—Permeability and moisture holding capacity of soils 9 months after the application of VAMA.

Soil type	Amount of VAMA	Permeability: Water/hr. 1st hr.	Permeability: Water/hr. 7th hr.	Soil moisture: Tension ⅓ atm.	Soil moisture: Tension 15 atm.
	%	inches	inches	%	%
Series of 1951, Experiment 1					
Pratt fine sandy loam	0	1.40	0.81	7.5	3.6
	0.025	1.87	1.27	7.7	4.2
	0.1	1.57	0.84	7.7	4.1
	0.2	2.43	1.78	7.0	4.7
Wabash silt loam	0	0.98	0.61	21.3	8.1
	0.025	1.61	0.84	20.3	8.4
	0.1	2.31	1.45	18.1	9.1
	0.2	4.24	2.41	17.5	10.4
Sutphen clay	0	2.23	1.17	35.5	19.0
	0.025	2.70	1.00	34.2	19.1
	0.1	3.10	1.04	35.2	18.9
	0.2	3.42	1.75	35.3	19.4
Series of 1952, Experiment 1					
Lancaster fine sandy loam	0	0.71	0.40	15.0	6.3
	0.1	1.28	0.98	16.6	7.2
	0.5	2.58	2.04	14.6	9.0
	1.0	9.51	7.54	15.0	12.7
Ulysses silty clay loam drift	0	2.37	0.69	28.6	18.2
	0.1	2.72	1.49	27.6	18.8
	0.5	5.00	4.47	28.6	18.1
	1.0	13.98	13.84	27.3	19.9
Sutphen clay	0	3.70	1.51	33.2	20.4
	0.1	4.80	2.82	32.7	23.8
	0.5	9.39	8.81	30.9	24.4
	1.0	10.20	9.91	31.8	22.9

EFFECTS OF VAMA ON WATER-STABLE STRUCTURE, PERMEABILITY, AND MOISTURE HOLDING CAPACITY (EXPERIMENT 1)

In fall, 4 months after treatment, VAMA showed a significant increase in size and proportion of water-stable aggregates in all soils tested, including fine sandy loam, silt loam, silty clay loam, and clay (table 1). In all soils, aggregation increased in proportion to the amount of VAMA applied. A substantial increase in aggregation was obtained even with as low a rate as 0.025%.

In the spring, 9 months after treatment, following the winter's effects of freezing and thawing, all VAMA-treated soils had a significantly greater proportion of water-stable aggregates > 0.84 mm. than untreated soils (table 1). However, a considerable breakdown of these coarse water-stable aggregates occurred on the VAMA-treated soils, especially during the winter of 1951–52.

The next fall, 15 months after treatment, the proportion of coarse water-stable aggregates was still considerably higher in the treated than the untreated soils, though not as high as in the previous fall, 4 months after treatment (series of 1952, table 1). The treated soils failed to regain the proportion of coarse water-stable aggregates which they lost during the winter. Little change in water-stable aggregates occurred at any time in the untreated soils.

Soil permeability increased appreciably due to treatments with VAMA. In the 1951 experiment, permeability was more than doubled on Pratt fine sandy loam, nearly doubled on Sutphen clay, and quadrupled on Wabash silt loam by application of 0.2% of VAMA 9 months previously (table 2). In the 1952 experiment, soil permeability was likewise increased substantially by applications of VAMA; the higher the rate of application, the greater was the increase in soil permeability.

In the 1951 experiment, there were only small differences in the water-holding capacity of treated and untreated soils (table 2). In the 1952 experiment, in which substantially greater quantities of VAMA were used, the amount of moisture available for plant growth decreased appreciably in Lancaster fine sandy loam, but changed little in the finer textured soils.

EFFECT OF VAMA ON DRY AGGREGATE STRUCTURE AND ERODIBILITY BY WIND (EXPERIMENTS 1 AND 3)

In previous studies it was found that erodibility of well mixed, freshly cultivated soils can be estimated approximately from the proportion of dry fractions < 0.84 mm. or < 0.42 mm. they contain (2, 4, 10). The fraction 0.42 to 0.84 mm. is generally erodible, and the fraction < 0.42 mm. is highly erodible by wind. These fractions can be determined readily by dry sieving. Any influence that VAMA has on erodibility by wind would be indicated, in part at least, by its influence on the proportion of dry erodible soil fractions. However, the conditions of the soil surface, such as the presence or absence of a surface crust, which is not always reflected by results of dry sieving, also influences erosion of soil by wind. Therefore, it was thought best to make direct measurements of erodibility of soils before and after cultivation and to find out if erodibility can be attributed to any measured or observed structural characteristics of the soils.

Dry aggregate structure and erodibility in the fall.—Four months after mixing VAMA into the soils and before winter set in, both in the 1951 and 1952 experiments, the VAMA-treated soils contained, on the average, a smaller proportion of dry fraction < 0.84 mm. in diameter than the untreated soils (table 3). As expected, the treated soils were substantially less erodible than the untreated soils immediately after they were thoroughly mixed by tillage (table 4). However, the erodibility of the treated soils before tillage did not always parallel the erodibility after tillage. No tests of erodibility were made in the fall of 1951 prior to simulated tillage. At that time all the soils were crusted over, due to excessive rains in 1951, and appeared highly resistant to erosion by wind. The summer and fall of 1952, on the other hand, were dry, except for occasional light rain. Under these conditions the surface of the VAMA-treated Ulysses silty clay loam drift and Wabash clay became looser, more granulated and more susceptible to wind erosion than the surface of the same untreated soils (table 4, column 8). Evidently under the influence of repeated wetting and drying such as occurred at the surface of the ground, VAMA acted as a soil mellowing or granulating agent. Unfortunately, the granules formed were too small to resist the wind.

The amounts of erosion on the treated and untreated soils were relatively low in the fall of 1951 and 1952. During the spring, following repeated freezing and thawing, soils generally disintegrate to a condition highly erodible by wind. It is also in spring that high winds are generally encountered. For these reasons the effectiveness of any product in reducing erodibility of the soil by wind must be based primarily on its ability to reduce erodibility during the spring.

Dry aggregate structure and erodibility in the spring.—In the spring of 1952, 9 months after treatment, the soils receiving VAMA did not have an appreciably more developed dry aggregate structure than the untreated soils (table 3). These results are in marked contrast with those of the previous fall when virtually all rates of application showed a substantial decrease in amount of dry erodible soil fractions. Apparently the action of freezing and thawing during the winter considerably reduced the originally favorable effects of VAMA.

The condition of the surface was markedly different on the treated and the untreated soils in the spring of 1952. The untreated soils were more or less cemented together and had an appreciable surface crust. When tilled, they turned up an appreciable proportion of large clods resistant to wind erosion (figure 1, left). The treated soils, on the other hand, were looser, more friable and had a more or less granular surface. A slightly clodded but fairly loose condition was found below the surface (figure 1, right).

The VAMA-treated soils were, on the whole, more wind-erodible than the untreated soils—at least before they were mixed thoroughly by simulated tillage (table

Table 3.—The effect of VAMA on the size distribution of dry aggregates.

Soil type	Proportion of VAMA	Dry aggregates: In fall, 4 mo. after treatment			In spring, 9 mo. after treatment		
		>6.4 mm.	6.4–0.84 mm.	<0.84 mm.	>6.4 mm.	6.4–0.84 mm.	<0.84 mm.
	%	%	%	%	%	%	%
Series of 1951, Experiment 1							
Pratt fine sandy loam	0	6.1	9.0	84.9	3.0	1.2	95.8
	0.025	20.4	14.8	64.8	0.8	3.0	96.2
	0.1	17.6	19.0	63.4	1.2	4.8	94.0
	0.2	31.3	15.7	53.0	7.0	7.9	85.1
Wabash silt loam	0	37.0	19.4	43.6	10.4	10.6	79.0
	0.025	44.0	26.2	29.8	5.9	18.4	75.7
	0.1	28.2	38.3	33.5	3.9	20.8	75.3
	0.2	41.2	27.2	31.6	6.2	20.1	73.7
Sutphen clay	0	49.7	35.9	14.4	1.4	16.3	82.3
	0.025	43.8	39.4	16.8	1.3	17.5	81.2
	0.1	45.7	36.7	17.6	1.2	15.8	83.0
	0.2	48.4	35.7	15.9	1.3	20.9	77.8
Series of 1952, Experiment 1							
Lancaster fine sandy loam	0	10.9	26.5	62.6	66.0	7.8	26.2
	0.1	12.4	26.4	61.2	41.8	12.6	45.6
	0.5	30.5	25.4	44.1	35.7	19.4	44.9
	1.0	45.9	23.3	30.8	66.9	13.0	20.1
Ulysses silty clay loam drift	0	5.9	9.4	84.7	19.3	12.1	68.6
	0.1	6.9	9.6	83.5	5.8	8.5	85.7
	0.5	19.6	11.9	68.5	8.2	9.4	82.4
	1.0	31.9	11.4	56.7	18.0	10.8	71.2
Sutphen clay	0	4.1	21.1	74.8	7.1	17.2	75.7
	0.1	4.1	20.6	75.3	2.8	14.6	82.6
	0.5	10.1	23.5	66.4	1.3	14.5	84.2
	1.0	23.4	26.0	50.6	7.9	13.3	78.8

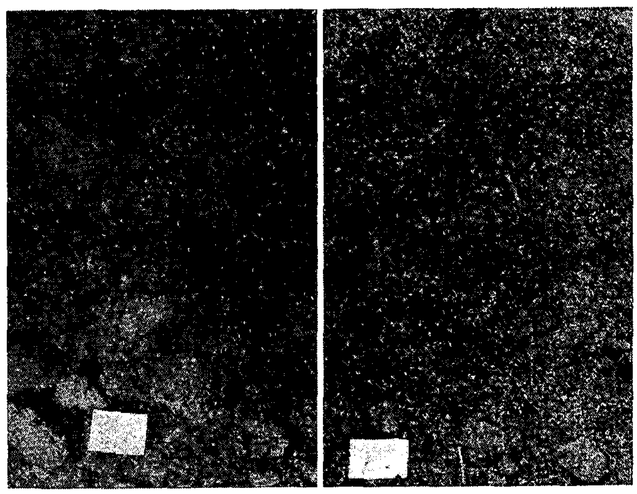

FIG. 1.—Appearance of Wabash silt loam immediately after simulated tillage. Left: soil not treated with VAMA; right: soil treated with 0.1% of VAMA 9 months previously.

Table 4.—The effect of VAMA on soil erodibility by wind. (VAMA was thoroughly mixed with the soil.)

Soil class	Series of 1951, Experiment 1					Series of 1952, Experiment 1						
	Proportion of VAMA	Erodibility				Proportion of VAMA	Erodibility					
		Fall 1951		Spring 1952			Fall 1952		Spring 1953		Fall 1953	
		Before tillage	After tillage	Before tillage	After tillage		Before tillage	After tillage	Before tillage	After tillage	Before tillage	After tillage
	%	tons/acre	tons/acre	tons/acre	tons/acre	%	tons/acre	tons/acre	tons/acre	tons/acre	tons/acre	tons/acre
Fine sandy loam	0	Not determined	27.0	1.8	48.2	0	0.2	2.5	0.8	0.4	0.4	0.9
	0.025		11.2	3.9	52.9	0.1	0.2	2.4	1.0	0.6	0.3	0.6
	0.1		10.3	4.1	49.3	0.5	0.2	0.8	1.6	1.0	1.5	0.6
	0.2		5.8	2.9	31.6	1.0	0.2	0.2	0.6	0.04	0.6	0.3
Silty soil	0	Not determined	1.2	0.5	4.0	0	0.2	11.5	0.4	2.0	0.2	4.0
	0.025		0.4	1.1	3.6	0.1	0.4	10.0	6.8	14.5	0.3	6.5
	0.1		0.6	3.0	3.9	0.5	2.0	3.7	55.3	26.7	0.9	7.4
	0.2		0.6	1.1	2.9	1.0	2.4	1.8	6.8	6.5	1.7	4.6
Clay	0	Not determined	T	0.5	6.8	0	0.2	5.2	0.7	4.0	0.3	5.7
	0.025		T	2.9	4.3	0.1	0.3	5.4	8.8	19.6	0.6	7.6
	0.1		0.03	2.2	7.0	0.5	1.4	3.2	42.6	56.2	2.1	17.0
	0.2		T	1.9	3.6	1.0	1.4	1.2	15.2	7.1	2.2	15.3

4). The higher erodibility of the VAMA-treated soils before tillage was due to a loose and finely granulated soil surface. The granules were not large enough to resist the force of high wind. The untreated soils, on the other hand, were protected to some degree by a surface crust. The highest rate of VAMA application (0.2%) produced a more coarsely granulated soil than the lower rates, and these soils did not drift so badly. A rate of application higher than 0.2%, it was thought, might have produced a structure resistant to wind erosion. Hence, a second series of experiments with much higher maximum amounts of VAMA was initiated during the following year.

Results from the second series of experiments were even less favorable in reducing erodibility by wind. The soils treated with VAMA 9 months previously all had a substantially greater proportion of erodible fractions (table 3), and were more erodible by wind both before and after they were tilled (table 4). The proportion of erodible fractions and the amount of erosion was highest on soils treated with 0.5% of VAMA. The soils treated with 1% of VAMA had a smaller proportion of erodible fractions and were less erodible than soils treated with 0.5% of VAMA. However, two of the soils out of the group of three treated at this rate were still more granulated and more erodible than the untreated soils.

Dry aggregate structure and erodibility 15 months after treatment.—Analyses were made again in September, 1953, to find whether soils treated with VAMA had regained their initially favorable structure. Results of these analyses showed that the treated soils remained generally looser, more friable, and more erodible by wind than the untreated soils (table 4). The favorable dry aggregate structure first developed with VAMA and later destroyed by frost during the winter was not regained during the following summer.

Results of field plot experiment 3.—There was no detectible effect of VAMA applied as dust or as spray in the field plot experiment of 1951. Rains during the summer of 1951 were frequent and soil was wet almost continuously. Under these conditions it was impossible to mix VAMA thoroughly with the soil. It was evident that the failure of VAMA to produce any detectible effect was due to a wet condition of the soil at the time of application. But a lesson was learned. VAMA must be applied to soil in a reasonably dry condition and must be thoroughly mixed with the soil. Perhaps the greatest stumbling block in the use of VAMA under field conditions is the problem of thoroughly mixing it with the soil. Special machinery may have to be adapted or devised for this purpose.

RESULTS OF APPLYING VAMA ON TOP OF THE GROUND (EXPERIMENT 2, 1952)

VAMA applied in the form of spray to the soil surface in 1951 without further disturbance of any kind had little effect on soil erodibility 4 months after treatment (table 5). However, erodibility was extremely low during that period due to almost continuous rains which caused both the treated and the untreated soils to be crusted badly.

In the spring, 9 months after treatment, the soils sprayed with VAMA in amounts up to 67 pounds per acre were slightly more erodible than the untreated soils (table 5, column 4). This increase in erodibility was due to the granulating effect of VAMA. Treatments with 260 pounds of VAMA per acre reduced the erodibility slightly, apparently by producing a certain amount of granules too coarse to be moved by wind. Considerably larger rates of application, it was thought, might have produced a soil condition resistant to wind erosion. Therefore, a second series of experiments with much higher maximum amounts of VAMA was initiated during the following year.

Results from this second series of experiments, conducted during a relatively dry year, were ultimately discouraging. When VAMA was applied as dust to the surface of the soil and the soil was wetted, a film was formed which appeared quite resistant to wind erosion. Three months after treatment, however, the film was pretty well disintegrated on all soils. When tested in the wind tunnel, the soils treated with amounts up to 260 pounds per acre were slightly more erodible than

Table 5.—Effect of placing VAMA on top of the ground.

Soil type	Amount of VAMA	Erodibility	
		In fall, 4 mo. after treatment	In spring, 9 mo. after treatment
	lbs/acre	tons/acre	tons/acre
	Series of 1951, Experiment 2		
Pratt fine sandy loam	0	0.9	6.7
	14	0.3	8.0
	67	0.4	7.8
	260	0.4	5.7
Wabash silt loam	0	0.2	6.2
	14	0.3	5.9
	67	0.3	6.7
	260	0.2	5.6
Sutphen clay	0	0.2	2.0
	14	0.2	2.0
	67	0.2	3.8
	260	0.2	1.6
	Series of 1952, Experiment 2		
Lancaster fine sandy loam	0	0.2	0.8
	130	0.4	1.0
	260	0.2	1.2
	1,300	0.1	1.5
Ulysses silty clay loam drift	0	0.4	0.4
	130	0.9	0.8
	260	0.8	2.3
	1,300	0.4	4.2
Sutphen clay	0	0.2	0.3
	130	1.2	0.4
	260	0.4	2.0
	1,300	0.1	6.0

the untreated soils, although the differences were not statistically significant (table 5, column 7). Erodibility decreased a little as the amount of VAMA was increased to 1,300 pounds per acre.

The following spring the soils treated with VAMA were all much more erodible than the untreated soils (table 5, column 8). Erodibility increased in proportion to the amount of VAMA applied. The soils treated with VAMA had a loose, highly granulated surface condition. The majority of the granules were too small to resist the wind. The untreated soils, on the other hand, were more compact, and had a distinct wind-resistant crust.

RESULTS OF APPLYING HPAN ON TOP OF THE GROUND (EXPERIMENT 2, 1953)

Since VAMA applied before winter was ineffective in controlling wind erosion the following spring, a new series of tests was initiated in which a conditioner was applied during the spring. A hydrolized polyacrylonitrile (HPAN) in powdered form was used instead of VAMA because this form is somewhat hydroscopic and the surface soil treated with it was thought to be more moist than where treated with VAMA. HPAN was dusted evenly over the surface of three types of soil at two different rates. After dusting, the soil surface was sprayed with about 0.1 inch of water and transferred in trays to the field. One week after treatment the soils in the trays were tested in an undisturbed condition in the wind tunnel. The results were entirely unsatisfactory (table 6). The surface film produced by the application of HPAN contracted, cracked, and curled up after it dried. It was detached readily by the wind. The film associated with the higher rate of application was thicker but it curled up even more and offered no greater resistance to wind than the thinner film. Two months after treatment the HPAN film disintegrated into granules highly erodible by wind.

Table 6.—Erodibility of soils 1 week after dusting HPAN on top of the ground.

Amount of HPAN	Erodibility		
	Lancaster fine sandy loam	Ulysses silty clay loam drift	Sutphen clay
lbs./acre	tons/acre	tons/acre	tons/acre
0	0.86	3.83	0.64
120	0.72	3.58	0.45
1,200	1.27	2.45	1.26

Discussion and Conclusions

VAMA was beneficial in producing good soil tilth and increasing soil permeability. Both of these characteristics tend to reduce erosion by water and increase crop yields. On the other hand, VAMA was ineffective in controlling erosion of soil by wind, except in some cases for short periods after it was applied. VAMA, in fact, increased the erodibility by wind due to its granulating action, especially after undergoing freezing and thawing during the winter season. In this respect, the effects of VAMA are similar to the granulating action obtained from large amounts of decomposed organic matter (6).

VAMA increased the proportion of coarse water-stable aggregates and decreased the proportion of fine water-dispersible particles < 0.02 mm. in diameter. These effects persisted even after repeated freezing and thawing during the winter. From this standpoint, VAMA can be considered an effective soil aggregating agent. However, the proportion of nonerodible water-stable aggregates (> 0.84 mm.) formed by VAMA was generally too small to increase the resistance of the soil to wind. The majority of water-stable aggregates formed by VAMA were of a size susceptible to erosion by wind (0.02 to 0.84 mm.). From previous study, it has been found that a soil must contain an appreciable proportion of coarse water-stable aggregates > 0.84 mm. or fine water-dispersible particles <0.02 mm. in diameter to resist the force of wind (3). It is evident from this study that VAMA tends to increase erodibility of soil by wind by aggregating some of the fine, wind-resistant, water-dispersible particles (< 0.02 mm.) into aggregates erodible by wind.

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