Synthetic Soil Conditioners

new synthetic organic materials under study for their effectiveness when added to certain California soils

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The following article is a condensation of a more detailed report on the subject of synthetic soil conditioners which is available without cost by addressing the Office of Agricultural Publications, 22 Giannini Hall, University of California, Berkeley 4, California.

Soil conditioners available commercially, including CRD-186 and CRD-189—Krilium—are synthetic organic materials. They consist of complex, long chain molecules containing hundreds of atoms each. They are light colored, water soluble and hygroscopic—moisture-absorbing.

The chain-like molecules of these new conditioners are thought to form bridges which hold together the clay particles and thus preserve the clusters of soil particles—or aggregates—typical of soils with good structures.

These materials are said to produce aggregation in much the same way as certain components of natural soil humus which are formed in small quantities during the decomposition of plant residues, manures, and other organic materials. In contrast to the natural organic matter, CRD-186 and CRD-189 are reported to resist decomposition by soil organisms.

The influence of CRD-186 upon the formation of soil aggregates and their resistance to dispersion by water was studied for nine different California soil series. The treated soils received additions of the synthetic compound at the rate of .1% by weight. The conditioners were thoroughly mixed with the air-dry soils, and the mixtures then sprinkled with water before again being mixed. Except for the addition of conditioners, the untreated soils were prepared in the same way as the treated.

To examine the effect on the treated soils of exposure to weather, the treated and the untreated soils were placed in vertical, open-ended, metal cylinders of about 0.8 square foot cross-sectional area. The soil columns were approximately eight inches deep and made contact with the undisturbed subsoil of a small field.

After one week the soils were sampled and air-dried in the laboratory before analysis. The addition of 0.1% CRD-186 brought about a significant increase in content of water-stable aggregates greater than one-fourth millimeter in average diameter. The greatest absolute increases in aggregation were observed in the silt loam, loam and sandy loam soils. These medium and coarser textured soils displayed a low initial aggregation. The least pronounced effect was observed in the finer-textured soils which, without treatment, already possessed more than 65% by weight of water-stable aggregates.

One soil in the tested group—the Sweeney clay loam—is naturally high in organic matter.

To study the effect on treated soil of exposure to the influences of soil moisture, weather, and micro-organisms, five of the nine soil types were exposed out of doors in Berkeley for 18 weeks between December 12, 1951, and April 18, 1952. During this exposure period, 23″ of rain were recorded at the weather station one-half mile away. Between storms there were several rainless and sometimes sunny periods when the surfaces of the soils became partly dried.

Samples of the soils were collected for aggregate analysis 18 weeks after exposure and represented the entire 8-inch columns.

Except for the Arbuckle sandy loam, all of the untreated soils were found to contain somewhat higher quantities of water-stable aggregates at the end of the four months than at the beginning. Of the treated soils all but Stockton clay showed a much greater aggregation than was produced by the weather alone in the untreated soils.

The influence of the added synthetic soil conditioner persisted during 18 weeks with only slight average gains and losses in the measured aggregation.

Upon wetting and drying, CRD-186-treated soils tend to break up into smaller blocks separated by finer cracks than untreated soils. In exposed cylinders at Berkeley the treated soils cracked, forming many small lumps when dried. The untreated soils showed fewer cracks and formed massive lumps in the container.

In a preliminary study on a recently leveled field in Glenn County, CRD-189 was applied dry and cultivated in. The field was then sown to Sudan grass. After several flood irrigations in strip checks, the cracking pattern of the surface soil was examined. The soil of the treated plots cracked to give an average of 36.1 blocks per square foot while the untreated had 19.9. Similar observations have been made in connection with studies on the use of synthetic conditioners to improve seedling emergence.

In the Berkeley experiments, no measurements were made of rates of infiltration into the treated and untreated soils, but rain water was often observed to remain longer on the surface of the untreated soils.

When water is applied to a soil, the pore spaces for a short time may become

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Influence of 0.1% by Weight of CRD-186 upon Percentages by Weight of Water-Stable Soil Aggregates[1] Coarser than 0.25 Millimeter. All Soils Were Wetted and Air-Dried before Wet-Sieving.

Soil	One week after addition (December 12, 1951)			Eighteen weeks after addition (April 18, 1952)		
	Untreated	Treated	Increase	Untreated	Treated	Increase
Arbuckle sandy loam	45	92	47	38	87	49
Hesperia sandy loam	49	92	43	..	..	..
Yolo loam	22	97	75	26	83	57
Dublin loam	43	94	51	49	90	41
Yolo silt loam	19	64	45	21	74	53
Sweeney clay loam	78	100	22	..	..	..
Dublin clay	87	98	11	..	..	..
Hugo clay loam	77	96	19	..	..	..
Stockton clay	67	85	18	92	91	−1
Average of nine soils	54	91	37	..	..	..
Average of five soils	39	86	47	45	85	40

[1] Water-stable aggregate measurements are made by sieving the soil on a screen under water and determining that proportion of the soil by weight, after oven-drying, too coarse to pass through the openings.

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is determined, V-bars should be used in alfalfa only with great care.

The amount of material passing through the cylinder had a pronounced effect on seed damage in alfalfa. In one case, a machine operating at a very light load damaged 17% of the seed. When the material rate was tripled, the damage dropped to around 7%.

The spike tooth cylinder was tested extensively in alfalfa where it performed very much the same as the rasp bar.

Typical Seed Losses under Average and Heavy Loads in Irrigated Alfalfa and Red Clover Stands with Seed Yields of 800 to 900 Pounds per Acre.

Crop	Swath width feet	Speed mph	Mat'l rate lb./min.	Seed losses, % of total yield		
				Free	Unthreshed	Damaged
Alfalfa	9	0.6	60	0.01	0.3–1.2	2 & up
	9–10	1.2–1.5	120	0.2–1	0.8–1.5	0–3
Clover	8½	0.4–0.5	40	0.2–0.3	2–5	3–4
	8½	0.8–0.9	80	0.3–0.5	4–11	1–3

The Cleaning Shoe in Alfalfa

In alfalfa the standard grain-type straw walkers carried half of the weight of material passing through the machine. The cleaning shoe handled the other 50%. In addition, the shoe carried a large volume of tailings which were returned to the cylinder and recirculated. Thus the amount of tailings increased the shoe load 60% to 70%.

Laboratory and field tests indicated that the most significant single factor affecting the loss of free seed was the amount of material passing over the shoe. As the load was increased, the seed loss went up sharply.

A number of different chaffers were tested in machines operating in alfalfa. In most cases the wind from the fan was adjusted until tests with a sampling pan indicated that the free seed loss over the shoe was at a minimum at normal material rates. Then runs were made at several different material rates without further adjustments. The graph on page 11 shows the results of these tests.

The type of material passing over the chaffer affected its operation. Straw had a much more adverse effect on separation than an equal weight of fine material. The free seed loss was normally influenced by the bulk, rather than the weight, of material passing over the shoe. Apparently tailings did not have as adverse an effect on separation as might be expected.

The double chaffer tested—with a No. 2 no-choke in the usual position and a larger No. 0 no-choke about 3″ above—gave the best results. The drawback with the double chaffer was that too high a percentage of free seed was deposited in the tailings.

The standard adjustable lip chaffer gave the next best results—when properly adjusted with the sieve open 9/16″. When the chaffer was only 3/8″ open, the losses were considerably greater.

A ripple chaffer — a nonadjustable type—performed well in alfalfa. This chaffer had crosswise corrugations or steps, with 3/4″ openings along the back side of the steps. At lower material rates the ripple chaffer was very efficient, although at higher rates the loss went up rapidly. There seemed to be little tendency for the stems and sticks to fall through and clog the sieve underneath. The nonadjustable chaffer may not do quite so good a job as a properly-set adjustable chaffer, but it is much superior to an improperly set adjustable unit.

Field tests on the effects of the amount of wind on the ripple chaffer performance showed that as air velocity decreased from a maximum, seed losses decreased, up to a certain point. With further reduction in air velocity the seed loss began to increase. This was contrary to laboratory results, where seed losses continued to decline as the wind was decreased. The apparent cause of this discrepancy was the tremendous increase in recirculated tailings in the field machine at lower wind rates. At minimum wind, well over half the material on the shoe was recirculated tailings, and these excessive tailings undoubtedly boosted the free seed losses.

An analysis of the tailings under normal conditions indicated 10% to 20% of the total seed yield was recirculated in the tailings. Furthermore, three fourths of the material collected in the tailings is superfluous, and could be eliminated without losing any unthreshed pods.

Small amounts of tailings apparently fill up the spaces in the straw, without greatly increasing the volume of the load. In this case there is comparatively little increase in free seed loss. Even when an excessive amount of tailings is present. the resulting loss of free seed is not so great as would be caused by an equal volume of straw.

The Cleaning Shoe in Clover

In red clover the straw walkers retained only about 30% of the total material, while the other 70% loaded up the shoe. On the other hand, the tailings rates were lighter than in alfalfa, averaging only 25% of the net shoe load.

Three types of chaffers were compared in clover. The most effective one tested was the adjustable lip sieve open 1/2″ to 5/8″. The ripple chaffer showed greater losses, particularly at higher material rates. The chaffer setup with the highest free seed loss was the double no-choke arrangement, which performed so well in alfalfa.

The studies reported here indicate small-seeded legumes can be threshed satisfactorily with present types of harvesters if properly modified, adjusted and machine loads are kept at the proper level.

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almost filled to the depth wetted. Within a few days in well-drained soils, some of this water will move downward and perhaps horizontally. The amount of water retained by the soil after drainage has occurred is called the field capacity. Plants can not extract all of this moisture for their normal functioning. and wilting occurs at a moisture content characteristic of the soil which is called permanent wilting percentage. For practical purposes, the difference between field capacity and permanent wilting percentage is the available water.

The field capacities of soils can be estimated by standard laboratory determinations called the moisture equivalent and one-third atmosphere percentage. The permanent wilting percentages may be obtained directly by growing small sunflower plants in the soils or estimated indirectly by what is called the fifteen-atmosphere percentage.

By measuring the effect of soil conditioners on these soil-moisture characteristics, their influence on total soil moisture available to plants can be evaluated.

Moisture equivalents and sunflower permanent wilting percentages were determined for Yolo soils ranging in texture from loamy sand to clay. CRD-189 at the rate of 0.1% by weight was mixed

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Dieldrin for Thrips

control of citrus thrips is possible but further studies are needed

W. H. Ewart and H. S. Elmer

Dieldrin has shown outstanding promise in the control of citrus thrips on oranges, grapefruit, and lemons during three years of experiments.

Experimental work completed so far reveals that control can be achieved by two pounds of 25% dieldrin wettable powder—or one pound 50% wettable powder—in 100 to 200 gallons of water. The amount of water depends on the desired rates of application per acre. In any case one-half pound of actual dieldrin per application should be applied.

Good control was also achieved with one-third gallon of 15% dieldrin emulsifiable concentrate in 100 to 200 gallons of water.

Applications were made at the rate of 100 to 200 gallons per acre per application, with equipment capable of applying low-volume sprays uniformly to the outside parts of the trees, including the tops.

Not more than 200 gallons per acre should be applied until more information is available.

To prevent fruit scarring of oranges or grapefruit, a single application was made as near as possible to the end of the petal fall period. On lemons, two treatments during the summer were sometimes necessary to prevent injury to new growth. The first treatment was applied when thrips began to damage new growth in May or June, the second treatment in late July or early August.

Treatments of dieldrin should not be made within 30 days of harvest to avoid excessive fruit residues. Detailed studies of harvest residues indicated that applications at rates and times listed above did not leave detectable amounts of dieldrin in the juice and pulp of the fruit, and only slight amounts in the peel.

Dieldrin appeared to be compatible with standard commercial formulations of zinc oxide and zinc sulfate plus soda ash. Other materials commonly sprayed on citrus trees, including miticides, other insecticides, and other nutritional supplements should not be added to dieldrin sprays until further tests are made on the use of such mixtures.

More tests are also needed on the effect of dieldrin on beneficial insects, and possible hazard to humans and livestock.

On the basis of studies so far completed, there is evidence that dieldrin, applied for the control of citrus thrips, does not seriously reduce the population of the ladybird, vedalia, which controls cottony-cushion scale. This beneficial insect suffers when DDT is applied.

There is also evidence that treatments of dieldrin do not result in heavy populations of soft brown scale such as occasionally occur following applications of parathion.

There is little or no information available on the effect of dieldrin treatments on parasites and predators of other citrus pests, including several species of mites and aphids that occur on citrus.

Studies are under way on the effect of dieldrin on honeybees. Until the evaluations are completed, applications of dieldrin for prevention of fruit scarring should be made as near the end of the flowering period as practical. If groves must be treated before the end of the petal fall period—because of irrigation schedules or for other reasons—beekeepers having bees within the area should be informed at least 48 hours before applications so the bees can be removed.

Dieldrin—like most insecticides—is a poisonous material. Protective clothing should be worn at all times while handling or spraying dieldrin.

Studies are not completed on the effect of dieldrin sprays on livestock or poultry which may come in contact with the spray or its residues. Until more information is available, dieldrin should not be applied where there is a danger of the spray drifting into livestock and poultry shelters or feeding areas.

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with air-dry soil, the mixture moistened, and the moisture equivalents run without preliminary air-drying of the treated soil. Addition of the chemical compound produced no distinct changes in moisture equivalents or permanent wilting percentages and hence no increase in available water. In fact, where the loam was wetted and dried three times before the determination, moisture equivalent and available water were decreased.

The water-retention characteristics of CRD-186 treated soils of four other soil series were investigated, using apparatus which permitted determination of the amount of water held under a number of pressures, including one-third and fifteen-atmospheres. The soils were air-dried after incorporating the synthetic conditioner. The one-third atmosphere percentage—approximate field capacity—of the conditioned soils tended to be lower, particularly with the Sweeney clay loam. The fifteen-atmosphere percentage—approximate permanent wilting percentage—was little affected. These measurements indicate that the addition of 0.1% CRD-186 does not increase the available water but may diminish it somewhat by reducing the amount of water held after drainage.

In more detailed studies, CRD-186 and CRD-189 were added to five soils at various rates. Use of as little as 0.02% conditioner by weight caused some decreases in moisture equivalent. Additions of as much as 0.4% CRD-189 gave small increases in moisture equivalent. It is doubtful, however, if the slight variations observed are of practical importance.

Although CRD-186 and CRD-189 do not directly increase the available water held by a given quantity of soil, such conditioners in some soils may indirectly enlarge the supply of water available to the plants. If their use aids the infiltration of water into the soil or encourages deeper and more extensive plant root systems, plants could extract water from a greater volume of soil. This would permit less frequent irrigation and more efficient water use. However, under the conditions of the Glenn County plots, use of CRD-189 did not improve infiltration rates and so did not permit the storage of additional moisture.

Studies in progress at the University of California on how synthetic soil conditioners may affect plant growth have not been completed.

The use of CRD-186 and CRD-189 to reduce soil crusting and improve seedling emergence is under investigation by several departments including Agronomy, Vegetable Crops, Soils, and Floriculture and Ornamental Horticulture. To date no conclusive results have been obtained.

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