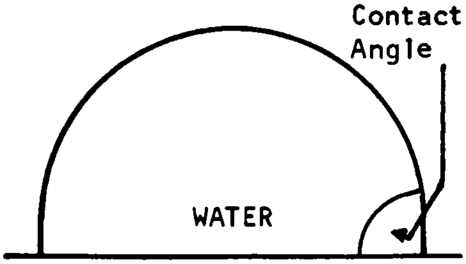

HYDROPHOBIC SURFACE
A

WETTING AGENTS

can increase water infiltration or retard it, depending on soil conditions and water contact angle

J. LETEY • R. E. PELISHEK • J. OSBORN

HYDROPHILIC SURFACE
B

HYDROPHOBIC SURFACE
C

Wetting agents are being marketed as means of increasing water infiltration of soil. At present no recommendation either for or against their use in irrigation water can be made that will cover every soil condition. However, certain effects of wetting agents on water entry are known, and these indicate conditions under which wetting agents are most likely to be beneficial.

When a liquid comes into contact with a solid, it forms a contact angle with the solid. The contact angle depends on the properties of the solution and the solid. On a hydrophobic (water-resistant) surface, such as wax, a drop of water "balls" up to form a large contact angle (Diagram A). On a hydrophilic (water-receiving) surface, such as glass, a small contact angle is formed, and the water spreads (Diagram B).

If a wetting agent is added to the water to reduce its surface tension, and the water comes into contact with a hydrophobic surface, the solution forms a lower contact angle, thereby wetting more of the surface (Diagram C).

How do surface tension and contact angle affect water infiltration rates? Water enters a soil primarily as a result of capillary and gravitational forces. Capillary force is the more important during the initial period of infiltration. Modification of surface tension has little effect on gravitational force, but it does affect capillary force. Decreasing surface tension decreases capillary force, but at the same time the accompanying decrease in the contact angle increases the force. The addition of a wetting agent, therefore, on the one hand reduces capillary force, and on the other, increases it. What must be determined is which effect predominates, the beneficial or the detrimental.

If the surface to be wet is not water-resistant, addition of a wetting agent will be of little benefit because the already low contact angle cannot be lowered much more. If the surface to be wet is hydrophobic, however, the contact angle can be considerably modified by a wetting agent, possibly to the point of overcoming the bad feature of reduced surface tension. In other words, the effectiveness of a wetting agent depends on the nature of the solid that is to be wet.

Another problem concerning wetting agents is their residual effect. When a hydrophobic surface has been wet with water plus a wetting agent, and the water has evaporated, what happens when the surface is wet again, with plain water? Three possibilities exist: (1) the surface would remain the same, and water would wet it as shown in diagram A; (2) the surface would have been made hydrophilic, the water would retain its high surface tension and wet the surface as in diagram B; (3) the wetting agent would redissolve in the added water to produce essentially the same condition as when it was originally applied in water.

An experiment was set up to show the importance of the contact angle and to learn more about the residual effect. White quartz sand was washed to remove silt and clay. Chaparral litter was extracted with ammonium hydroxide, and the extract was poured over two batches of sand. (The litter extract had previously been found to make the sand more hydrophobic.) Each batch of sand was sieved into various sizes. The 30- to 60-mesh fraction was packed into glass columns, and the time required for infiltration of 50 ml of solution was measured. (The glass tubes were treated with paraffin dissolved in xylene so that they would not be more wettable than the sand.) Tap water and three commercial wetting agents (diluted to concentrations recommended on the containers) were used in the checks. After the initial run, the sand was removed, allowed to dry, and repacked in the tubes. Water was then rerun through the tubes as a check on the residual effect of the wetting agents. (Sand was used rather than soil because wetting and drying did not alter the structure, and the original packing could be reproduced.) The table shows relative infiltration times.

On the untreated sand, wetting agents

RELATIVE TIME REQUIRED FOR 50 MILLIMETERS OF SOLUTION TO INFILTRATE SAND COLUMNS

Solution	Untreated sand		Treated sand No. 1*		Treated sand No. 2†	
	Initial time	Water re-run	Initial time	Water re-run	Initial time	Water re-run
Water	1.0	1.0	1.0	1.0	1.0	1.0
Product A	1.2	1.3	0.7	0.6	0.8	0.5
Product B	1.3	1.3	0.7	0.6	0.8	0.6
Product C	1.3	1.3	—	—	0.8	0.6

* Time for water entry 3.1 times that in untreated sand.
† Time for water entry 1.8 times that in untreated sand.

were detrimental to infiltration both on the initial run and the rerun. The rerun pattern suggests that the wetting agent dissolves in water to create a situation similar to the initial solution. The decreased infiltration on the untreated sand was probably a result of reduced surface tension, which was not overcome by a more favorable contact angle since water wets sand at a fairly low angle.

On the treated sand, the wetting agents increased infiltration, especially on sand treated to be least wettable. In these cases, the decreased surface tension effect was surpassed by the creation of a more favorable contact angle. The rerun on treated sand resulted in even better infiltration than the original. This indicates that if some of the wetting agent did dissolve in the added water, the surface tension was not reduced to that of the original solution, and the wetting agent had a favorable effect on the surface, reducing the contact angle.

These results show that much depends upon the contact angle between the soil and water, and that wetting agents are most likely to be beneficial when the surface is hydrophobic. Further studies of contact angles existing under natural conditions should indicate whether widespread use of wetting agents to promote better infiltration of irrigation water would be practical.

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The above progress report is based on Research Project No. RRF 1979.

SOIL NUTRIENTS after BRUSH BURNING

Tests with greenhouse plants show that burning increases supply of nitrogen, phosphorus, and sulfur in soil

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A program of brushland conversion from chaparral cover to the more useful cover of grass and clover has been in progress in California for several years. In many situations, prescribed burning is used to accelerate brush disposal. Because of the hazards involved, prescribed burning is performed under specified conditions of temperature, humidity, season of the year, and with approved fire-crew supervision.

Burning the vegetative cover of brushland increases the soil supply of nitrogen, phosphorus, and sulfur available to subsequent vegetative types more suitable for livestock grazing.

Greenhouse pot tests with Romaine lettuce and Atlas barley as indicator plants were conducted to determine the effect of broadcast brush burning on the nutrient supply of a soil as measured by plant growth.

The soil tested was a Parrish loam taken from the east slope of the Coast Range in western Tehama County at an elevation of 1,700′ where the average annual rainfall is about 30.″

The Parrish soils, developed from hard sedimentary rocks, have brown, slightly acid, medium textured surface soils, and reddish brown, slightly to medium acid, fine textured subsoils. Parrish soils are 2′–3′ deep and occur on hilly to steep foothills with a dense stand of shrubs. The area sampled supported a dense cover of chamise and buckbrush about 6′ high. The soil samples were collected shortly after an autumn burn. Test soil was taken from an 8″ depth in the burned area and check soil was taken from an unburned area located about 200′ distant but similar to the burned site in soil, slope, and vegetative cover.

The soils were sieved and put into painted 6″ pots holding 1,600 grams of soil each.

A check series of pots was set up to measure the inherent fertility of the soil. Appropriate chemicals were added to other pots to give a complete treatment containing nitrogen, phosphorus, potassium, and sulfur. Further treatments omitted one nutrient at a time to measure the soil supplying power for each element

Lettuce growth on Parrish soil sampled from (left) burned, and (right) unburned areas.