Proper application of chemical anticrustant improved chances of a good seedling stand

Close-up showing faster drying and crusting of dense nonstabilized soil surrounding a treated spot. Emergence was 167 percent higher in treated spots, with larger and more vigorous tomato plants.

Crust control aids seedling emergence

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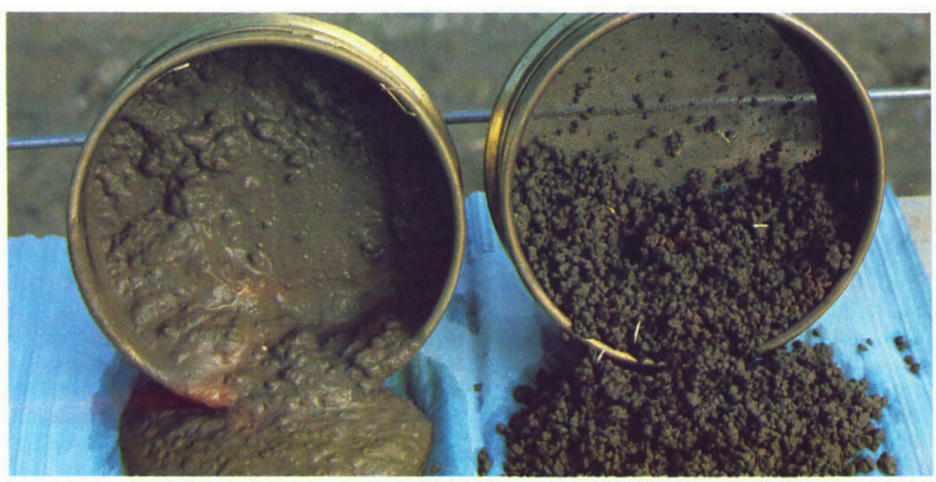
Many agricultural soils form dense crusts on the surface after a rain or irrigation, which reduce or prevent seedling emergence and result in costly replanting or lowered yields. Soil crusting is a problem as old as cultivated agriculture, but there are no cures that are universally used and economical, or that work on all affected soils.

As part of a six-year study on crust control, over 30 important California crop soils were used, including clay, sand, silt, loam, and peat. Types of soil anticrustants tested included anionic and cationic polymers, polyvinyl alcohol, acids, dry organic compounds, copolymers, petroleum mulches, surfactants, liquefied organic materials, and compounds for coating soil aggregates with waterproofing.



Two-millimeter aggregates stabilized by immersion in Nalco solution and dipped in water (right) will not wash through 0.5-mm screen until broken up. Nonstabilized aggregates (left) dispersed after dipping in water, and will pass through the screen.

Elvanol 71-30, a polyvinyl alcohol by DuPont; Nalco 2190, a cationic polymer by Nalco Chemical Company; and HI-CAT, a cationic polymer by Buckman Laboratories, were especially effective. After saturating a soil aggregate, all three prevented dispersion and crusting after wetting and drying; all produced immediate and long-lasting effects. Aggregates treated with Nalco 2190 and HICAT did not bind to each other upon drying; Elvanol caused a slight binding. Nalco 2190 was selected for the studies reported here for its nontoxicity to plants and soil, its safety, ease of handling, and availability, and because it produced results equal to or better than those from all other products tested.

Crusting occurs after soil crumbs, or aggregates, have been broken up into smaller and smaller units through water or mechanical action. These dispersed soil aggregates then become bonded together in a layer on the surface as the soil dries after wetting. Aggregates larger than 1 mm show weak bonding, with little crusting. Dispersion into very fine aggregates causes high density and oxygen problems whether crusting takes place or not.

The goals of any anticrusting system are to prevent dispersion and to eliminate bonding between aggregates. The types of anticrustants that prevented mechanical dispersion usually caused aggregates to stick together in an undesirable fabric. Those found to be most effective in this study were the ones that prevented crusting but increased aggregate resistance to the force of heavy rain only slightly. The mechanical preparation of a seed bed determines

Effect of anticrustant on seedling emergence when applied by spot-saturation method

Trial and crop	Planted	Anti crustant applied*	Crust formed†	Emergence	Percent increased emergence‡
1 Tomato	2/14	2/22	2/28	3/10	21**
2 Tomato	2/17	2/17	3/2	3/8	72***
Cabbage			3/2	2/26	25**
Lettuce			3/2	2/26	43**
Onion			3/2	3/10	15**
3 Tomato	2/20	2/23	3/2	3/17	167***
4 Cabbage	2/26	3/3	3/2	3/12	38**
Lettuce			3/2	3/12	9ns

* 20 to 40 ml of 1.5% Nalco 2190 solution applied.
† In trial 1, a light crust formed following a light shower immediately after planting. A severe crust was formed in all trial plots by a 1.8-cm heavy rain on 3/1, followed by several weeks of showers.
‡ Percent increased over control. Significant at probability levels of **0.01 and ***0.001, based on binary comparisons

Plant growth in stabilized soil (left) compared with nonstabilized soil. Both had been subjected to heavy watering.

the initial aggregate size mixture, which in turn determines the initial crusting potential. None of the anticrustants tested caused aggregation or improved the soil structure; the main property of the anticrustant is to preserve the existing condition, whether favorable for emergence or not.

Proper application essential

Trials in which the anticrustant was applied in the traditional band-spray on the soil resulted in erratic, unpredictable, and not easily reproducible results for either emergence or crust control. An improved application method, called aggresizing, was developed in which an anticrustant solution was rubbed vigorously into the soil until it became damp. Extensive greenhouse trials demonstrated that aggresized soil, when used to cover the seed, eliminated crusting and improved emergence.

A machine was built for field use, which aggresized a soil band with anticrustants, planted the seed, and covered it in one operation. For cost effectiveness, the treated band was made 7 cm wide (2 to 3 inches) and 1 to 2 cm deep (about ½ to ¾ inch). Planting in this narrow band resulted in the mixing of treated and nontreated soil and reduced the effectiveness of the process — a problem that was later overcome by a new machine. Although field aggresizing always reduced crusting (as measured by a penetrometer) and increased emergence, the improvement was not as great as desired.

A saturated-spot technique became the method of choice in the greenhouse for its simplicity, low cost, and effectiveness; it completely eliminated crusting in all cases when used in over 60,000 pots in 300 experiments. The technique consists of pouring 30 to 40 ml (about 1 to 1⅓ fluid ounces) of the anticrustant material in one spot so that it penetrates at least 1 cm deep — a highly desirable depth. The procedure has proved reliable and reproducible, so that it has become routinely used in the greenhouse: seeds are planted, and the top 1 cm of soil wet with a 1.5 percent Nalco 2190 solution, followed immediately by the first watering.

Effective crust control was found to depend on the initial application of solution penetrating as deeply as stabilization is desired — usually 1 to 1.5 cm. Once applied, these materials do not leach or move downward readily when more water is added. Treated spots remain visible and are soft and granular to the touch with no crust, while the nontreated surrounding area crusts and becomes hard. Effective solution strength varies with the material; all performed satisfactorily over a wide range of concentrations. Nalco 2190 solutions of 0.5 to 1.5 percent were effective.

When sprayed on soils, the solutions penetrated only about 1 to 2 mm (up to about 1/16 inch) deep. This thin layer readily cracked under crusting conditions, allowing nontreated soil to mix with the thin stabilized layer and reducing effectiveness. One can see how a thin treated layer becomes ineffective by placing a surface-sprayed aggregate in a glass of water and watching the untreated lower area disperse and mix with the thin stabilized surface shell.

Field trials

By 1981, our work showed that Nalco 2190 was representative of the best anticrustants, that it could be used as a standard for comparing others, and that it had to be applied by the saturated-spot technique for best results. The addition of such materials as liquid iron, zinc, other nutrients, and fungicides to the Nalco 2190 solution also was found to enhance emergence, vigor, and plant protection under some conditions.

In 1981 a simple, mechanical spot-saturation applicator was developed, and preliminary field trials were conducted. Crusting was not a major problem that year, however.

Four large trials were planted in February and March of 1982 in a clay loam soil. Crusting was severe; 12 cm of rain fell during the cool emergence period in three of the trials. Each trial consisted of 4 to 18 treatments; all included a 1.5 percent Nalco 2190 solution as a base but had different additives. Only the main effect of Nalco 2190 is considered in this report. The saturated spots were approximately 6 cm by 12 cm and 1 to 1.5 cm deep, placed at 1-meter intervals along seed rows. Dates of planting, spot application and crust formation are provided in the table.

Each spot was marked, and emergence in the 10-cm central section of each spot was compared with that in a 10-cm nontreated check midway to the next spot. In trial 3, for example (which is representative of the others), the 360 treated spots were thus compared with 360 nontreated spots.

As crust formed in the rest of the field, all treated spots remained clearly visible as nondispersed, noncrusting areas along the row. These spots remained loose and granular for about six weeks, well after emergence.

One result noted in the extensive greenhouse and field trials was that elimination of crusting does not guarantee emergence, since that also depends on proper aeration, on temperature, and particularly on water management. However, the probability of a better stand increases when crusting is prevented.

The importance of deep stabilization by spot saturation for effective crust control has been found to be essential for all but very mild conditions. Cost of the material at the 1.5 percent strength we tested would be about $15 to treat 37,000 spots in 1 acre.

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