# SOIL CRUSTING

## *effects on potato plant emergence and growth*

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INORGANIC SOILS of the San Joaquin and Sacramento valleys planted potatoes often crust in early spring. Crust strength and thickness are conditioned by the amount and intensity of rainfall, soil clod stability, and rate of drying of the soil surface. In the past there has not been much information about the extent to which crust development can affect plant performance. In the spring of 1970 the effects of severe soil crusting upon potato plant emergence and development were observed and recorded at Shafter.

**Crust formation**

The influence of raindrop impact and soil clod breakdown on prepared beds was recorded from earlier observations of plantings made in Yolo sandy loam soil at the U.C. Vegetable Crops Research Farm, Davis. A comparison of protected and exposed portions of beds revealed that prevailing rain from the south induced more clod breakdown and thicker crust development on the southern exposure of the bed than on the northern (photo 1). Periodic measurement of the soil atmosphere indicated no harmful reduction in the amount of oxygen for plant needs nor build-up of carbon dioxide. Cracks in the furrow developed readily within a day or so after each rain, and with time these cracks extended into and split crusted bed shoulders, allowing uninterrupted gas exchange. No adverse plant development or yield reduction was found with crusting of this soil. However, rainfall or mismanagement of sprinkler irrigation on some soils planted to potatoes in Kern County could be harmful to plant development under certain conditions.

Between March 1 and March 5, 1970, more than one inch of rainfall was recorded at the USDA Cotton Research Station, Shafter. Following furrow irrigation, intense rains of short duration fell on bare Hesperia sandy loam soil that had been planted February 19. Raindrop impact destroyed the moist surface clods, rearranging the soil particles, which formed a layered structure upon drying. Thereafter, conditions for drying of the surface were favorable. Crust thickness varied, tapering from thickest on the bed top down towards the furrow (photo 2). Crust strength and the cohesion of soil

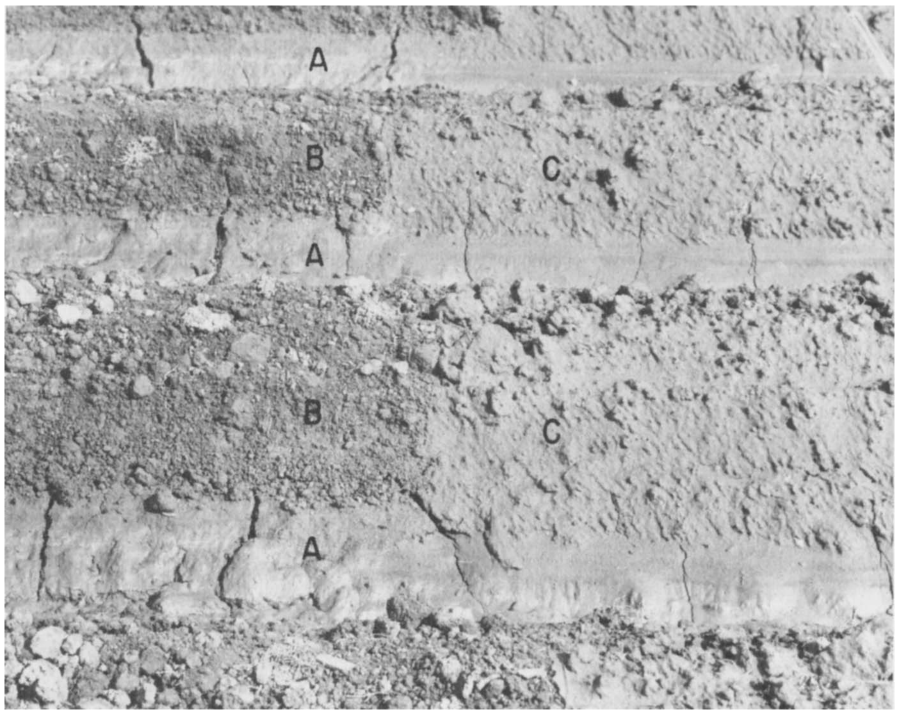


Photo 1. The influence of rain on clod breakdown is shown in this comparison of protected bed (B) with exposed bed (C) of a Yolo sandy loam soil planted to potatoes at the Department of Vegetable Crops Farm, Davis. Beds faced east-west, with furrows (A) exhibiting cracks.

Photo 2. Cut-away view of crusted bed and adhering soil beneath crust of Hesperia sandy loam soil planted to potatoes at the U.S.D.A. Cotton Experiment Station, Shafter.

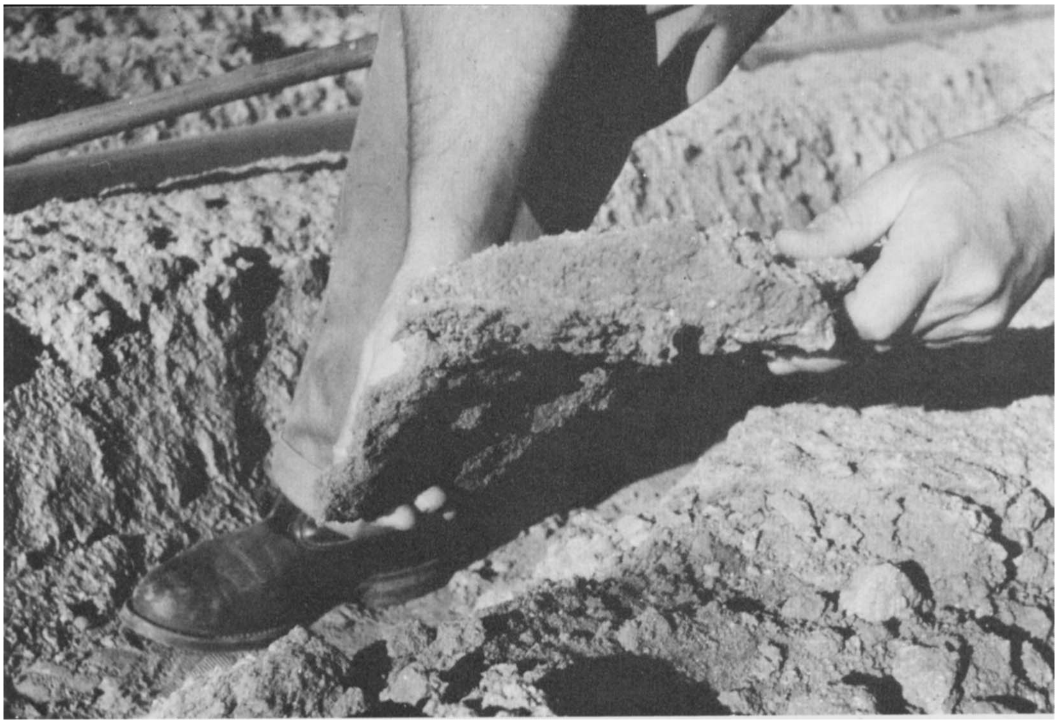

**Photo 3. Portion of crusted bed of Hesperia sandy loam soil easily removed by hand, attesting to the strength of the crust, which sometimes exceeded 3 inches in thickness.**

**Photo 4. Drying of crust on the shoulder of beds caused shrinkage, and cracks developed (arrow) between the crust and wetter soil of furrows. Uninterrupted gas exchange allowed adequate oxygen in the soil for plant needs.**

particles beneath the crust were such that chunks as thick as 3 inches were easily removed by hand without breaking (photo 3).

As the crust became drier, shrinkage occurred and occasional cracks developed in the thinner-layered sections of the bed and between the wet soil of the furrow and the drier sides of the beds (photo 4).

## Plant growth

Stems encountering the soil crust responded in one of three ways: (1) when the crust was thin or weakened by cracks, stems forced their way and emerged without apparent difficulty (photo 5); (2) where the crust was thick and exerted considerable resistance to upward growth of stems, the apex of the stem swelled (photo 6). In many cases a split occurred in the stem immediately below the swelling that was sometimes wide enough to allow free passage of a thin knife blade. The tissue in the area of the split became very brittle and subject to easy breakage later on when plants became larger.

This swelling of the apex increased the pressure that a plant was able to exert and, if greater than the resistance offered by the soil crust, could rupture the crust and lift large pieces out of the stem's way (photo 7). (3) Where the resistance of the crust was too great, the stem continued to grow beneath the crust (photo 8), sometimes twisting, only to emerge where a crack occurred in the crust or where a thinner, weaker crust was encountered on the side of the bed. Weak stems, however, failed to emerge and died, resulting in blank spaces.

Samplings of soil atmosphere indicated that oxygen was adequate for plant needs (never less than 18%) and that the amount of carbon dioxide was not excessive.

A delay of 10 to 30 days in plant emergence resulted from mechanical impedance of the soil crust, since adequate soil aeration and moisture prevailed. The marked delays in plant emergence sharply reduced crop productivity and lowered the yield of U. S. No. 1 tubers.

## Not isolated condition

Inspection of other potato fields (planted on Hanford sandy loam) 30 miles south of Shafter revealed that differences in plant emergence there were also caused by temporary soil crusting. A three-day delay between sprinkler irrigations allowed a crust to strengthen under prevailing drying conditions. Late-emerging plants showed the characteristic swelling of the stem apex just below the crust. Inspection of older plants also revealed split stems in some plants, immediately below the soil surface. Otherwise, the plants appeared normal and healthy. Remoistening of the soil with the next sprinkler application allowed plant stems to emerge without restriction.

**Photo 5. Potato stems easily emerged where cracks in the crust occurred in Hesperia sandy loam soil.**

## Possible disease infection

In addition to the reduction in plant yield potential from soil crusting, there is the possibility of introducing blackleg disease (*Erwinia atroseitotictica*) infection. Stem breakage associated with the split brittle stem tissue just below the soil surface could provide a site for entrance of the pathogen.

In the past, blackleg inoculation has been traceable to infected seed potatoes, but it also occurs by contamination through wounds received from insect feeding, through enlarged tuber lenticels, as a secondary infection following the entrance of an earlier pathogenic infection, and through mechanical damage (machine cultivation). Although no direct plant counts were made of the extent of blackleg infection, it is possible that the splitting and subsequent snapping of stems below the soil surface later in growth may offer some explanation of the heretofore unknown reason for random infection by this organism of otherwise healthy-appearing plants.

**Photo 6. Stem development beneath soil crust often displayed a marked swelling of the apex (arrow), accompanied by splitting of stem tissue behind the swelling often severe enough to permit passage of a thin knife blade.**

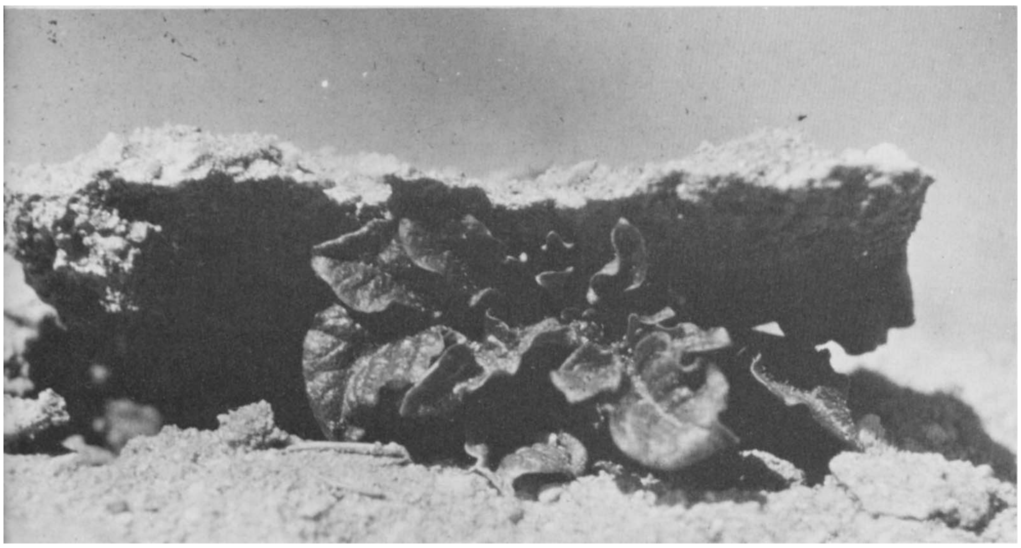

**Photo 7. Where crust was thin and offered minimal resistance, emerging plant stems exerted sufficient pressure to force relatively large chuncks out of the way.**

## Prevention

Crust strength can be reduced by several methods. With furrow irrigation the tops of beds remain dry and the crust can be broken mechanically. With sprinkler irrigation, however, it is a simple matter to maintain sufficient moisture in the bed surface to allow emerging stems to push aside soil particles without difficulty. As the soil surface becomes drier, the cohesive force of the particles in the crust becomes stronger, and plant stems must overcome this resistance or a delay in emergence results. The nature of soil crusting is not well understood, but its effects can be reduced by preventing loss of surface moisture during plant emergence. Under certain conditions, broadcasting and incorporation of gypsum into beds has been helpful in minimizing development of soil crusts.

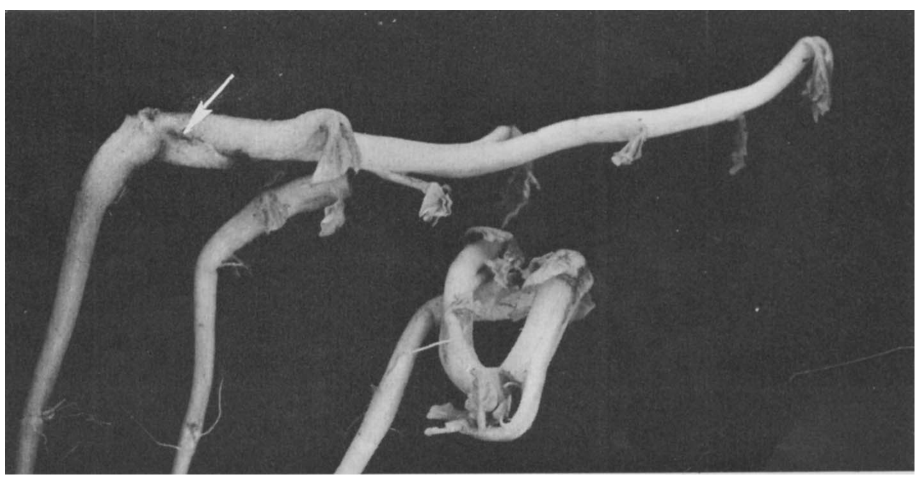

**Photo 8. Characteristic stem development beneath severe soil crust. Note split (arrow) near bend of upper stem; also, twisting and cracking of the lower stem (roots removed for easier viewing).**

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