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WATER FRONT STUDY FOR SPOT IRRIGATION

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ABSTRACT

In an attempt to study the water movement characteristics in a conical depression in a sandy soil, water was applied to such depressions of a simulated seed bed. Depressions were then covered with loose soil, compacted gently, and under some simulated local field conditions, its moisture front was studied periodically. It was observed that the wetting front had a parabolic shape and the drying pattern was changing with time according to the curves of Figure 1.

During the last twenty years a considerable amount of work has been done by agricultural designers on mechanization of sugar beet fields. A variety of precision planters have been designed and tested specially for the development of fully mechanized beet fields.

Some types of precision planters punch the single seeds into the soil to a desired depth. The one made at the University of Wyoming employed a punching wheel, which featured conical punchers on its rim (1). With this arrangement the seed metering system could locate single seeds in each of the equally spaced conical depressions on the rows.

In this connection a study at the University of Wyoming showed some possibilities of water incorporation with seeding to save on pre-irrigation water for sugar beets (2). It should be noted that this saving helps to solve water shortage problems at the time of sugar beet planting.

The water incorporation to be featured in such a planter would require a precision spot irrigator. Before designing an irrigator it would be helpful to know how the water,

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applied to each conical depression of the seed bed, would penetrate the soil and how it would evaporate in regard to the seed location.

The purpose of this study is to simulate the field conditions in a laboratory for a newly designed planter, add water to conical depressions in a soil, and study the form of wetting and drying fronts that take place in the soil. The specifications used match the design and operation of the planter and some local field conditions.

MATERIALS AND METHODS

A brass cone with a 3.2 cm height and 90 degrees cone index angle was mounted on a rigid plate, 18 x 18 cm, and used to make depressions in soil obtained from a sugar beet field of the Wyoming Agricultural Experiment Station at Torington, Wyoming. The soil, dried in air, had 5% moisture and passed through a sieve with 0.5 cm openings. The soil was placed in each of eight topless 20 x 20 cm plywood containers with removable side doors. The soil was packed by dropping the full containers of soil from 15 cm height 10 times. This increased the bulk density of the soil from 1.030 to 1.32 g/cm^3.

A single conical depression was made in each soil container by putting the cone plate on the soil surface and slowly applying 0.85 kg/cm^2 average perpendicular pressure on the soil by means of a hydraulic press. A 1.54 g/cm^3 bulk density was observed in the soil containers. To avoid spilling out, a maximum of 60 cc water, found experimentally was applied to the conical depression of each container over an elapsed time of 4 seconds. The water had soaked in completely after about 5 seconds, and the soil surface was covered with a 0.3 cm thick layer of loose soil and compacted to a 0.03 kg/cm^2 average perpendicular pressure.

The soil containers were put in a room with 21±2^{o}C temperature and a 6.4 km/hr wind was directed over them by means of an electric fan. Every 12 hours one container was opened by its side door and half of the soil was scraped off gently to leave a vertical soil surface which passed through the center of the conical depression. The moisture front was recorded by putting a square glass against this soil surface and tracing the margin of wet soil on it. Each curve of Figure 1 would then represent a trace of water boundary at its given time for a single soil container. It should be noted that the boundaries were not as sharp or as clear as shown in the figure.

Also 8 containers, prepared the same way as above, were opened ½ hour after the application of water to determine the characteristics of the water front before any appreciable evaporation took place from the soil.

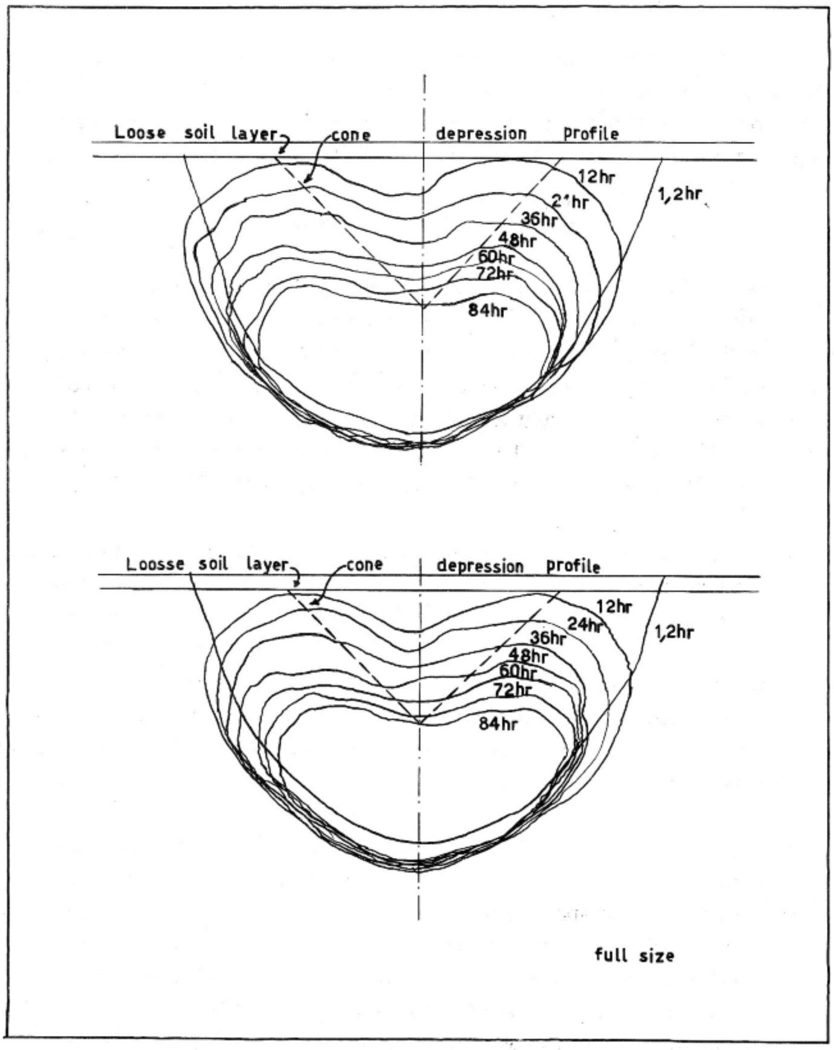

Figure 1. Two replications of the moisture boundary pattern

RESULTS AND DISCUSSION

The wetting pattern obtained ½ hour after application of 60 cc water to the conical depression (average of 8 replications) was a vertical parabolic solid, approximately 11 cm in diameter at the surface and 6.2 cm deep. All 8 replications had nearly the same wetting pattern indicating a uniform soil density and compaction in all the soil boxes.

The drying pattern during the evaporation phase of the test is presented in Figure 1. The area of moist soil declined as evaporation proceeded, but the lower moisture boundary remained at a constant level.

The following general trends might then be concluded from the results of this study:

1. The wetting pattern has a parabolic shape in a vertical plane passing through the axis of the conical depression. The ½ hr curve shown in Figure 1 shows pattern for the average of 8 replications.

2. The rest of the curves, showing the periodic change of drying front, all resemble the shape of Padcal's Limacon as shown in Figure 1. The lower moisture boundary of these curves stays fairly at the same level with approximately±2 mm vertical deflection.

LITERATURE CITED

1. Jafari, V.J. and K.J. Fornstrom, 1970 A precision Punch Planter for Sugar Beets Amer. Soc. of Agric. Engre. 70:109.
2. Lee, G.A., A.F. Alley, and G.A. Dowding, 1968 Weed Control in Sugar Beets Agric. Exp. Sta., University of Wyoming, Res. Jour. No. 27.