AN X-RAY TECHNIQUE FOR DETERMINING SEED PLACEMENT IN DIRECT DRILLED SOILS

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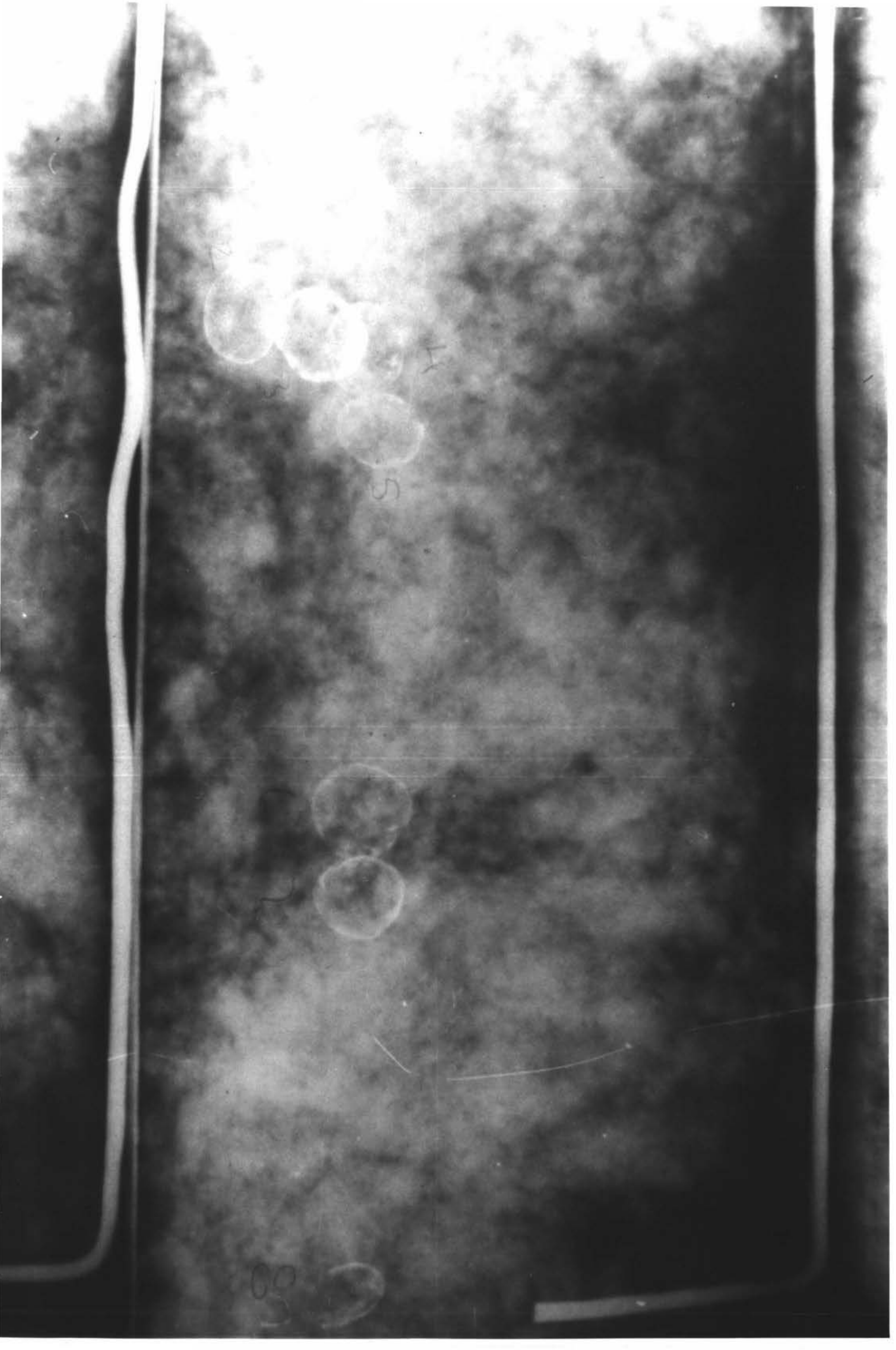

ABSTRACT

The objectives of this study were to develop and document a reliable workable X-ray technique for identifying seed placement in the soil; to examine those factors which might influence this procedure and to demonstrate the use of the technique in a field experiment.

The X-ray technique was based on the principle that seeds coated with a heavy metal powder, when X-rayed within a soil mass, appeared on the X-ray film as white or grey images on a dark background.

A coating procedure (based on commercial pelleting) was developed to apply the heavy metal powder to the seed. As the seed images on the X-ray film were to be a shadow representation of the actual seed position in the soil mass, a correction procedure to locate the true positions of the seed was developed.

A series of laboratory experiments confirmed that red lead oxide was the most suitable coating material and that higher intensities of coating were required as seed size decreased. Neither soil type nor soil moisture content appeared to have a marked affect on the clarity of the X-ray images. Seed germination was not affected by the amount of red lead oxide coating, the coating procedure, or exposure to moderate levels of radiation.

Soil blocks measuring 75 mm by 75 mm by 240 mm long containing the coated seeds should be taken as soon as possible after sowing, as image clarity diminished over time and seed movement occurred in the case of seeds with epigeal germination.

Equipment developed to assist in field sampling included a soil-block-cutter, re-useable sample bins and a holding jig for X-raying the soil blocks in their bins.

Thus the X-ray technique had the ability to determine three dimensional seed placement within a soil mass (sowing depth, in-row width and in-row spacing). The ability of the X-ray technique offers new possibilities for explaining those factors which affect seed placement by direct drilling equipment in field situations.

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1. INTRODUCTION

The general practice in crop production has been to till the soil to prepare a uniform level seedbed into which seeds were placed (Loveday, 1980). Increases in tractor fuel and labor costs, together with decreases in available labor, recognition of the need for erosion control and the development of modern herbicides have all lead to a reduction in cultivation and the concept of no-tillage or direct drilling (Allen, 1981; Dickey and Rider, 1980). Erbach (1980) described the difference between no-till and cultivated seedbed conditions. According to Erbach, in using conventional tillage the soil was worked to produce a smooth, level and uniform seedbed. In direct drilling, residues were either absent or left on the undisturbed soil prior to planting. As a result, direct drilling openers were forced to operate in a different soil environment compared with conventional seed drills.

Early work in developing direct drilling openers entailed using or modifying conventional openers (Allen, 1981; Erbach, 1980). This practice met with only limited success due to the harder nature of the direct drilling seedbed. Early modifications to direct drilling openers concentrated on improving the mechanical performance (Allen 1981, Erbach 1980). As mechanical performance improved, hitherto unidentified problems associated with biological performance became apparent (Baker, 1976; Erbach, 1980). One area which affected both mechanical performance and biological performance was the depth at which the seed was placed in the soil.

In an attempt to accurately determine seeding depth, Barr (1981) put forward an idea for coating seeds with a heavy metal coating and determining seed placement by removing soil samples and X-raying them to locate the position of the seeds in the soil.

The objectives of this project were: 1. To develop and refine the X-ray technique so that it could form a reliable and workable technique for determining seed placement by direct drilling openers in the field; and 2. to demonstrate the ability of the X-ray technique in evaluating seed placement by selected direct drilling openers in a field experiment.