DEVELOPMENT AND PERFORMANCE EVALUATION OF IMPROVED CLAY POROUS PIPES FOR SUBSURFACE IRRIGATION

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HIGHLIGHTS

- Clay and clay combined with zeolite was utilized for the production of clay pipes for subsurface micro-irrigation.
- Various modelling approaches are mathematically complex and require computational and technical skills, hence the need for other simpler approaches.
- Non-contact imaging and supervised classification (ArcGIS) techniques are utilized for wetting pattern study.
- The Plexiglas soil column experiment and incorporated techniques provide a visual understanding of soil-water movement interaction.

ABSTRACT. *The increasing prominence of clay pipes in irrigation water application in drier regions and the importance of soil wetting pattern information requires a better understanding of subsurface irrigation system design and management. This article reported findings on two different porous clay pipes made up of 100% clay, and 25% zeolite as an additive to the 75% clay developed and produced. A new method was proposed to evaluate their performance. A non-contact thermal imaging technique and maximum likelihood supervised classification algorithm on ArcGIS software methods were used for wetting pattern dimensions determination. A Plexiglas soil column filled with homogeneous sandy textured soil profile was used in laboratory experiments. The non-contact thermal imaging technique was used to capture thermal and digital images at different water application times. The images were then classified using a maximum likelihood supervised classification algorithm on the ArcGIS software interface. The results revealed that cumulative water applied increased with an increase in application time. The maximum predicted depth and width for modified pipes were 12.4 and 18 cm, respectively. For the non-modified pipes, the dimension was 11.2 and 17 cm for depth and width, respectively. The maximum recorded wetted area was 46.56% under modified pipes compared with 41.01% for non-modified pipes. The higher uniform area coverage was achieved under modified clay pipes rather than in the clay porous pipes. The study concluded that the proposed imaging technique predicted the soil wetting pattern dimension with acceptable accuracy and provided for a simple and visual approach.*

Keywords. *ArcGIS, Subsurface irrigation, Supervised classification system, Thermal imaging camera, Wetted depth, Wetted width.*

A subsurface micro-irrigation system improves water use efficiency due to its effectiveness in precisely supplying water at the right time directly to the crop rooting zone (Wang et al., 2019). Soil wetting patterns describe the extent and nature of how applied water to the soil travels while advancing in vertical and horizontal planes produces a certain pattern of the wetted area (zone) and its distribution within the wetted volume (Al-ogaidi et al., 2016a). Understanding the soil wetting pattern geometry involving width, depth, or radius for different application tools is vital for irrigation systems design, use, assessment, and management. These wetted zones vary with the type of water application devices and the nature of used application methods. Researchers use location-specific field experiments and under control environments in the laboratory and developed or use already developed simulations. In this regard, quantitative relationships were

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