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The efficacy of a novel polyacrylamide spray application method to mitigate soil crusting and enhance seedling emergence on crust susceptible soils

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Over 36% of the arable area in England is at moderate to very high risk of surface sealing/crusting and erosion, including much of the better-drained and more easily worked land, especially sandy soils (Evans, 1990).

The intensive production of leafy greens consists of short growing cycles –between 21 and 28 days- and intensive seedbed preparation. From seeding to emergence, the bare soil is susceptible to rainfall and irrigation induced soil sealing. The direct consequence is an impeded seedling emergence, a delay in stand establishment and reduction in plant populations, with direct impacts on productivity. To avoid soil sealing, the grower is required to undertake additional field operations such as breaking the crust, applying supplementary low intensity irrigations or, in extreme cases, replanting crops, in a vicious cycle that spirals into soil structure degradation, loss of nutrients and further soil-sealing susceptibility.

Polyacrylamides (PAMs) are long-chained carbon polymers featuring an amide functional group that allows them to form bonds with an array of soil surfaces. The efficacy of PAMs to stabilise soil aggregates and prevent soil splash, capping and erosion has been documented for >25 yrs. Further, it has been demonstrated that PAMs consistently outperform bio-polymers and other synthetic alternatives. However, a technological innovation is required to effectively spray PAM on to the soil surface as typically PAM's become extremely viscous when mixed with water making conventional spray application un-viable. This research investigates the efficacy of a dual-fluid nozzle to apply PAM to the soil surface. Conventional applications to mitigate soil sealing are either in powder form or diluted within the sprinkle irrigation system and are effective at application rates ranging from between 10 and 20 kg ha^{-1}[SR1] (Levy et al. 1992). However, the powdered form is extremely susceptible to wind drift, and the sprinkle irrigation alternative is severely limited by the amount of water required to deliver the same amount of product. Initial nozzle calibration results indicate that PAM can be applied at rates of 13-20 kg ha^{-1} using 110-150 litres of water ha^{-1} instead of 1000 m^3 ha^{-1}(Levy et al. 1992). Subsequently, the effect of three PAM formulations with contrasting molecular weight and charge density were tested on a crust susceptible soil. Soil microcosms were subjected to two consecutive simulated rainfall events, representing pre-emergence conditions of field grown leafy salads. Treatment performance was assessed in terms of degree of crust formation. This was quantified by assessing pre and post

rainfall changes in Soil Surface Roughness (SSR) using a Creaform HEXAScan laser scanner at 0.20 mm resolution, in infiltration rate using a Decagon Devices minidisk infiltrometer, and in crust penetrative resistance with a 3 mm diameter probe using an Instron 5542 tension and compression testing machine.