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Opinion

A Technology to Reduce Water and Fertilizers Requirements and Increase Plant Production

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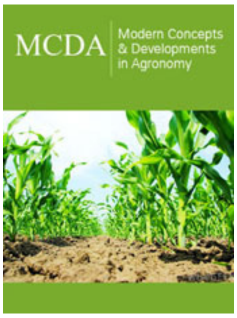
ISSN: 2637-7659



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Submission: February 15, 2023
Published: February 23, 2023

Volume 12 - Issue 3

How to cite this article: Mahdi Ibrahim Aoda, Alvin J Smucker. A Technology to Reduce Water and Fertilizers Requirements and Increase Plant Production. Mod Concep Dev Agrono. 12(3). MCDA. 000789. 2023.
DOI: 10.31031/MCDA.2023.12.000789

Introduction

Plant water deficits are among the greatest limitations to maximum plant growth potential. Water supplies and the safety of waterways in close proximity with international boundaries are facing national and international crises. In addition to dwindling surface water, large cities struggle daily with inadequate water supplies and related issues. As populations soar, local food supplies shrink and competition for water for agricultural production becomes unavailable or progressively more expensive. Regional capacities to deliver adequate water supplies are seriously strained, ushering us into greater limitations of water which cannot be reversed even by our children or grandchildren. The primary purpose of this report is to give an insight into a proven technology to double food production with a goal of reducing irrigation by 50% in arid regions. Since water is the most limiting input to agricultural production, and its resources are declining, new approaches beyond additional irrigation are needed to retain more water in the root zones of plants. Water scarcity is becoming more acute in most parts of the world, primarily due to the high evapo-transpiration rates and low rainfall due to global climate changes. Therefore, new approaches for conserving irrigation water must be designed to minimize water losses during surface additions of water and increase soil water holding capacity in the root zone. The rapidly expanding utilization of subsurface water and nutrient retaining membranes, combined with surface and subsurface drip irrigation tapes minimize surface water losses and deep leaching losses of water and nutrients below the root zone. The novel Soil Water Retention Technology (SWRT) has been proven to double crop production with 50% less supplemental irrigation [1,2]. Installing spatially positioned impermeable sheets below the root zone prevents water contents a little lower than field capacity from moving down below the depth of most roots. Yield results of maize grown on SWRT- improved sand soils, approached world records during the worst drought in the Midwestern region of the USA. Parallel water use efficiencies approached 200% [3]. This water saving and drought avoidance technologies have been highly successful with cucumbers, green peppers and maize in Michigan, grass in Turkey and cotton in Texas. Current research plans are expanding SWRT into Arizona, Florida, Missouri and Kansas. Using this technology in Iraq had almost double crop yields of tomato and spicy pepper and decreased irrigation requirements by 50% and also highly increase the irrigation water use efficiency [4].

It was proposed to demonstrate and confirm the revolutionary contributions of a newly proven water saving technology. Smucker et al. [3] that provides an environmentally safe reversal of water and nutrient losses from the root zones of plants growing in sandy soils. Thin polymer films were installed in a manner that simulates the thin natural clayey E horizons found in more productive sandy fields. A mechanical Barrier Installation Device (BID) has been designed, patented and tested by scientists and engineers at Michigan State University which accurately places polymer film at strategic depths beneath the root zone,

Figure 1. These membranes, either polyethylene (long term) or biodegradable polymers (short term) are the strategic components of the newly patented Michigan State University (MSU) Subsurface Water Retention Technology (SWRT). Laboratory, greenhouse lysimeter and field testing indicate SWRT membranes double the water storage capacity in the root zones of plants grown in deep sands. Consequently, we believe this new technology will maximize the conservation of water and nutrients in a manner that protects the environment and enhances soil quality and productivity. These many agro-ecological, environmental and hydrological attributes of the SWRT concept can greatly increase the production of both the quantity and quality of vegetables and grain crops, while using fewer fertilizers and much less supplemental irrigation water.

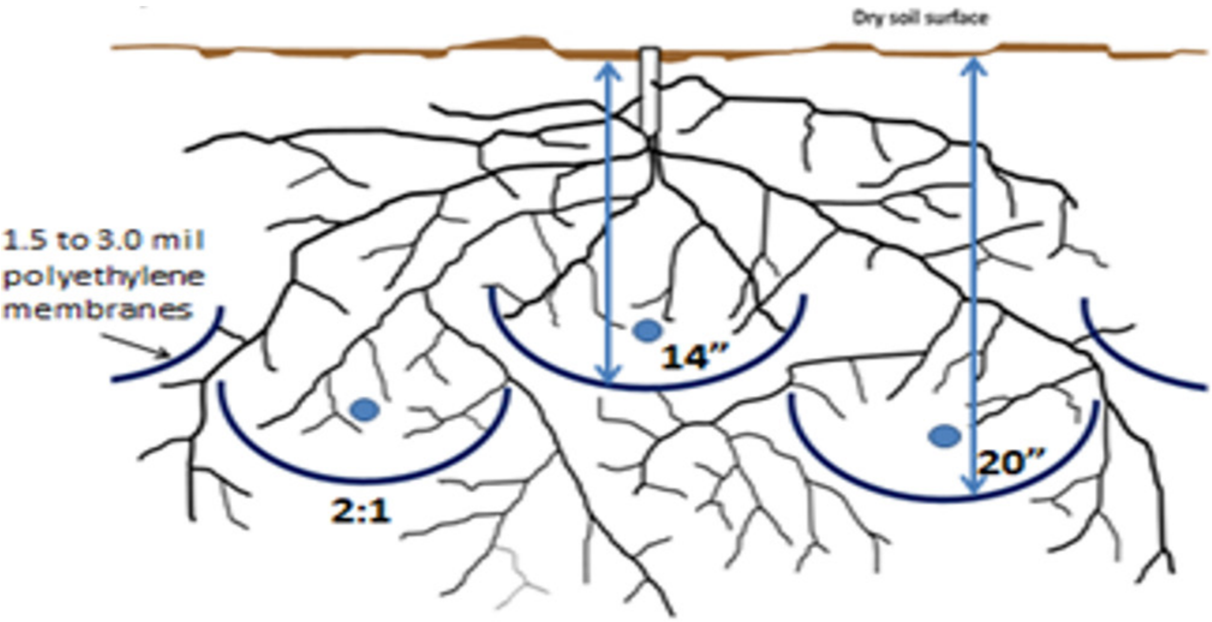

Figure 1: SWRT water saving membranes are contoured engineered high-density polyethylene (HDPE) films strategically spaced below plant root zone with space available for unlimited root growth and internal drainage during excess rainfall. Additions of John Deere Subsurface Drip Irrigation (SDI) pipes (.) 10cm above the SWRT water saving membranes provide best control of plant available water.

Among the multiple sources of materials available for SWRT barriers we have chosen short-term plant-based bio-degradable and longer-term polyethylene films which will be installed as level, double-depth 12-inches wide U-shaped "trough-like" barriers, Figure 1, arranged in parallel channels across entire fields and selected sandy knolls of eroded fields. Plant-available water retained at near field capacity, within each barrier row, with excess water draining over the top of the CEPEM edge, will dramatically reduce drought stress events for as much as 25-31 days per crop season even during the driest years. In fact, SWRT-improved fields will "retain the majority of water where it falls". These arrangements of the SWRT-improved soils will distribute highly uniform water contents to plant roots of crop rows planted any direction, from parallel to perpendicular, across the SWRT membranes.

Material costs of CEPEMs average $315 per acre for 2 mil-thick membranes and depend upon the tensile strength required to compensate for the sharpness of rocks in SWRT-improved soils. Membranes installed into finer textured soils may also require a specific density and diameter of perforations that permit partial drainage for adequate soil aeration, raising costs by 10 to 12%. Additional installation costs, based upon rentals of large 8 to 6-wheel tractors and the BID implements simultaneously installing 4 barriers at depths between 40 and 60cm are unknown. However, we have estimated total material and installation costs should not exceed $900 per acre. Although this initial cost may appear to be high, the long-term investment of a zero-maintenance SWRT water conservation technology should be less than $9 per acre per year when installation costs are amortized across the 100-year lifespan estimated for polyethylene CEPEMs. Installation rates for the SWRT water and nutrient retention systems are estimated to approach 10 acres per day for each four-unit BID installation machine.

Finally, it can be summarized that for most studies in different parts of the world the following results were obtained.

A. SWRT both enables more agricultural production with less water and also reduces the upward movement of saline waters.

B. SWRT membranes dramatically reduced deep leaching of toxic surface soil fertilizers and pesticides.

C. SWRT adds crop resilience to changing climate.

D. Greater crop residues improve soil health which continues to improve crop production and income of agricultural regions.

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