EFFECT OF SUPER WATER ABSORBENT ON PLANT GROWTH AND YIELD OF BELL PEPPER AND TOMATO UNDER POLY TUNNELS IN SRI LANKA

R.G.A.S. Rajapaksha[1], M.P.T. Premarathna[1], K. J. P. K. Kahawatta[1], E.R.S.P. Edirimanna[2], A. K. Rathnayake[3], K.R.C. De Silva[3] and Shyamalee Kohombange[1]*

[1]Horticultural Crop Research and Development Institute, Gannoruwa, Sri Lanka.

[2]Fruit Crops Research and Development Institute, Horana.

[3]Atomic Energy Board, Colombo.

*Corresponding Author

ABSTRACT

Super Water Absorbant (SWA) absorbs water and a release to the cultivation as far as the soil is de-watered and increased plant performances. SWA compounds were screened based on water absorption capacity and 320g water absorption per 1g of SWA was selected for this study. Objective of this experiment was to identify the effect of SWA on plant growth and yield of bell pepper and tomato in poly tunnels. Bell pepper and tomato plants were established in pots and standard crop management practices were done throughout the study. The experiment was laid out in a Completely Randomize Design with four treatments calculated according to the water holding capacity after incorporation of SWA into the potting media and randomized in four replicates. The amounts of water requirement of different treatments were calculated according to the water holding capacity after incorporation of SWA into the potting media. Bell pepper yield data reviled that T3 i.e. 4g SWA /1Kg potting medium was the effective SWA level and it saved 50% water amount with compare to the normal watering pattern. On the other hand, tomato yield data reviled that T2 i.e. 2g SWA /1Kg potting medium was the effective SWA level and it saved 40% water amount with compare to the normal watering pattern. However, Plant nutrient data of bell pepper and tomato showed there was not a significant difference among different treatments tested.

Keywords: Bell pepper, SWAs, Tomato, Poly tunnels

1. INTRODUCTION

The application of Super Water Absorbant polymers (SWAPs) for the purpose of enhancing soil water retention represents important nano engineering water conservation technique fordryland farming. This technique is widely used in producing crops such as apples, grapes, wheat, and maize [1–4], andit has proven to be effective in saving water and increasing yields. In many farming areas with limited water supplies, crop growth relies completely on rainwater. However, the uneven spatiotemporal distribution of precipitation and the soil's poor ability to conserve moisture keep rain water use efficiency low in these areas, exerting a direct impact on crop growth [5–7]. Applying SWAPs to the soil is effective in improving rain water use efficiency in dry land farming areas [8, 9], because SWAPs can repeatedly absorb and retain rain water entering the soil to reduce deep seepage losses and then gradually release the water to the plants as the soil dries and the plants' root pressure increases. This mechanism ensures a continuous water supply for plants during their growth periods [10, 11]. After treatment with SWAPs, soil demonstrates remarkable changes in its hydraulic parameters and water holding properties. Han et al. [12] found that the periodic absorption and release of water by SWAPs exert time-varying effects on the soil's properties, causing the hydraulic parameters in SWAP-treated soil to vary irregularly with time. Bai et al. [13] discovered that, during wet-dry soil cycles, the application of SWAPs can reduce soil's bulk density, with a higher SWAP dosage producing a greater effect. Other studies [14–17] have revealed that the repeated water absorption and release mechanism of SWAPs not only ensures water supply for plants, but also alters the pattern of soil water movement by influencing the soil's mechanical and chemical properties, local microbial communities, and root growth. This adds to the difficulty and complexity inherent in modeling water movement in soil to which SWAPs have been applied. Accurate characterization of soil's hydraulic parameter sand water retention properties is a key step in modeling water movement [18–20]. However, only a few studies have provided quantitative descriptions of the dynamic characteristics of SWAP-treated soil's hydraulic parameters [12, 21, 22]. SWA of different kinds could be useful in agriculture, rearing drought stress in plants, making better use of irrigation water and fertilizer. SWAPs can in principle influence soil permeability, density, structure, texture, evaporation and infiltration of water through soils [23]. SWA are two systems consisting of three dimensional network of polymer chains and water that fills the space between the macro molecules act as a SWA. Cross-linked polyacrylamides hold up to 400 times their weight in water and release 95% of the water retained within the granule in time to time. In agriculture SWA can be used as a water reservoir in arid and desert regions of the world. The soil is watered and the water not absorbed by the plant roots is stored in the SWA which swells, and releases water to the cultivation as far as the soil is de-watered. SWA help reduce water stress of plants resulting in increased growth and plant performance [24].

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2. MATERIALS AND METHODS

The study was conducted at poly tunnels located in Horticultural Crop Research and Development Institute, Gannoruwa (WU1- Central Province), Sri Lanka. Bell pepper and tomato plants were established in pots and standard crop management practices were done throughout the study. The experiment was laid out in a Completely Randomize Design (CRD) with four treatments randomized in four replicates. Four treatments were used as changing the amount of SWAs that incorporated to the potting medium.

Preparation of Super water Absorbent SWA

SWA compounds having different molecular weights were prepared by atomic energy board, Colombo, Sri Lanka by Gamma irradiation base technology. SWA compounds were screened based on water absorption capacity. One component having 320g water absorption per 1g of SWA was selected for the studies.

Table 1: Four treatments were used as changing the amount of SWAs that incorporated to the potting medium

Treatment	Amount of SWAs
T1	Control (recommended watering)
T2	2g SWA /1Kg potting medium
T3	4g SWA / 1Kg potting medium
T4	6g SWA / 1Kg potting medium

Alternative spraying of chitosan compounds (chitopower 1 and chitopower 2) was sprayed in weekly intervals for disease controlling. Neem seed water extract (50g seeds/one lit of water) was used as foliar spraying to control insects in 7 days interval. The amounts of water requirement of different treatments were calculated according to the water holding capacity after incorporation of SWA into the potting media.

Table 2: The amounts of water requirement of different treatments to maintain water holding capacity in potting medium were calculated according to the water holding capacity after incorporation of SWA into the potting media. (ml of water/pot (4kg of potting medium)/day)

Treatment	Rainy days	Sunny days
T1	200ml	400ml
T2	120ml	240ml

T3	100ml	200ml
T4	50ml	100ml

3. RESULTS AND DISCUSSION

3.1 Effect of Super Water Absorbent on growth and yield of bell pepper in Poly tunnels

Results revealed that the saved water amounts (%) of different treatments were increased with increasing the SWA amount that incorporated to the potting media (Table 3). Yield data showed that there was a significant difference between different treatments and the highest yield (g/plant) was observed in the treatment- T3 (4g SWA / 1Kg potting medium) (Table 4). N, P, and K content of bell pepper plants of different treatments were analyzed as major plant nutrients. However, there were not significant differences among different treatments (Table 5). Highest fruit yield and 50% water saving could be obtained by incorporation of SWA (320g water per one g of SWA) at the rate of 4g per kg of potting medium.

Table 3: Percentage Saved water amount between different treatments with compare to the normal watering pattern

Treatment	Saved water amount %
T1	0
T2	40
T3	50
T4	75

Table 4: Mean bell pepper yield with different treatments (g/plant)

Treatment	Mean yield (g/plant)	Yield improvement Compare to control (%)
T1	301.5^{c}	-
T2	391.3^{ab}	28.5
T3	398.9^{a}	32.3
T4	358.7^{b}	19.0

Note: Means followed by the same letter/s along the column are not significantly different at p=0.05

Table 5: Mean major plant nutrients (%) of bell pepper plants

Treatment	N%	P%	K%
T1	2.5	0.3	6.7
T2	2.7	0.2	6.7
T3	2.4	0.2	6.2
T4	2.5	0.3	6.9
	ns	ns	ns
CV %	8.1	32.6	12.2

Note: ns - not significantly different at p=0.05

3.2 Effect of Super Water Absorbent on Growth and Yield of Tomato in Polytunnels

Results revealed that the saved water amounts (%) of different treatments were increased with increasing the SWA amount (Table 6). Highest plant height was observed in the treatment- T2 (2g SWA /1Kg potting medium) (Table 7). Yield data showed that there was a significant difference between different treatments and the highest yield (g/plant) was given by the T2 (2g SWA / 1Kg potting medium) (Table 8). There was no significant difference in major plant nutrients of tomato plants between different treatments (Table 9).

Table 6: Percentage Saved water amount between different treatments with compare to the normal watering pattern

Treatment	Saved water amount %
T1	0
T2	40
T3	50
T4	75

Table 7: Mean plant height of tomato at 100% flowering stage of different treatments (cm)

Treatment	Mean plant height (cm)
T1	93.0^{ab}
T2	102.6^{a}
T3	67.8^{c}
T4	79.4^{bc}
CV %	18.7

Note: Means followed by the same letter/s along the column are not significantly different at p=0.05

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Table 8: Mean tomato yield of different treatments (g/plant)

Treatment	Mean yield (g/plant)	Yield improvement (%)
T1	412^{b}	
T2	480^{a}	16.5
T3	368^{b}	
T4	260^{c}	
CV%	18.2	

Note: Means followed by the same letter/s along the column are not significantly different at p=0.05

Table 9: Mean major plant nutrients (%) of tomato plants

Treatment	**N%**	**P%**	**K%**
T1	3.4	0.47	4.9
T2	3.0	0.45	5.0
T3	3.4	0.53	5.1
T4	3.1	0.51	4.8
	ns	ns	ns
CV %	8.9	14.9	12.2

Note: ns - not significantly different at p=0.05

4. CONCLUSIONS

Bell pepper yield data reviled that T3 (4g SWA /1Kg potting medium) was the effective SWA level for bell pepper and it saved 50% water amount with compare to the normal watering pattern grown in poly tunnels. Tomato yield data reviled that T2 (2g SWA /1Kg potting medium) was the effective SWA level for tomato and it saved 40% water amount with compare to the normal watering pattern grown in poly tunnels. Plant nutrient data of different treatments showed that incorporation of SWA into the potting medium had no significant effect on N, P, K content of bell pepper and tomato.

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