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Optimizing the strength of hydrophilic polymers on yield and its contributing traits in tomato

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ABSTRACT

To standardize the doses of hydrophilic polymers on growth and yield of tomato, a trial was conducted at Horticultural College & Research Institute, Tamil Nadu Agricultural University, Coimbatore. The hydrophilic polymers of commercially available viz., Terracottem (TerraCottem International, Belgium), polyvinyl alcohol (Aquatrols corp. of America, USA) and Polyacrylamide (Viterras, Germany) were chosen for the study and used as soil conditioners for tomato cv.Co.3.The results revealed that the TerraCottem 4.5g plant $^{-1}$ (T_{16}) improved the plant height, number of branches per plant, days to 50 % flowering, root length, root dry weight, fruits per plant, fruit weight, yield per plant and dry matter production. The results were on par with higher dose of respective polymers.

Key words : Tomato, Hydrophilic polymers, Standardization, Doses .

I. INTRODUCTION

Tomato, a needy vegetable, is always in great demand to meet the requirements of kitchen and processing industries. Constant supply of tomato should therefore be ensured, though it does not happen, not only to the local market but also to the industries. Though irrigated production is the norm for tomato, to a limited extent, it is also grown under rain fed conditions. Hence, the development of management practices to maintain soil moisture and improve physical condition of soil would greatly help sustain productivity of tomato under rain fed conditions. There are chances for retaining soil moisture within the root zone by using the water retentive materials such as hydrophilic polymers. In recent years, the use of these materials for improving soil physical properties, plant growth, development and yield has assumed significant importance. With this view, this study was conducted to standardize the optimum dose of hydrophilic polymers for yield and its contributing characters in tomato.

II. MATERIALS AND METHODS

The polymers such as TerraCottem (TerraCottem International, Belgium), Polyvinyl alcohol (Aquatrols corp. of America, USA) and Polyacrylamide (Viterras, Germany) were selected and used as soil conditioners for this study. These hydrophilic polymers were experimented on pot culture in a completely randomized blocks design with three replications. The seedlings were raised in seed pans and 25 day old seedlings were planted in earthen pots containing 1:1:1 red earth, sand and farm yard manure. The seedlings were planted in earthen pots and thinned to one vigorous plant after establishments. Just before planting, individual pots were applied with hydrophilic polymers at a depth of 15 cm.

The treatment details are as follows.

T_1 – TerraCottem 1.5g plant $^{-1}$.
T_2 – TerraCottem 3.0g plant $^{-1}$.

T_3 – TerraCottem 4.5g plant^{-1}.
T_4 – TerraCottem 6.0g plant^{-1}.
T_5 – TerraCottem 7.5g plant^{-1}.
T_6 – TerraCottem 9.0g plant^{-1}.
T_7 – Polyvinyl alcohol 3.0g plant^{-1}.
T_8 – Polyvinyl alcohol 6.0g plant^{-1}.
T_9 – Polyvinyl alcohol 9.0g plant^{-1}.
T_{10} – Polyvinyl alcohol 12.0g plant^{-1}.
T_{11} – Polyvinyl alcohol 15.0 g plant^{-1}.
T_{12} – Polyvinyl alcohol 18.0g plant^{-1}.
T_{13} – Polyacrylamide 2.5g plant^{-1}.
T_{14} – Polyacrylamide5.0g plant^{-1}.
T_{15} – Polyacrylamide 7.5g plant^{-1}.
T_{16} – Polyacrylamide 10.0g plant^{-1}.
T_{17} – Polyacrylamide 12.5g plant^{-1}.
T_{18} – Polyacrylamide 15.0g plant^{-1}.
T_{19} - Control (1:1:1 red earth, sand and farm yard manure)

III. RESULTS AND DISCUSSION

The results on the efficacy of various does of hydrophilic polymers were studied by assessing the plant height (cm), number of branches per plant, days to 50 per cent flowering, root length (cm), root dry weight (g) were presented in table 1 and the fruits per plant, fruit weight (g), yield per plant (g) and dry matter production (g) were presented in table 2.

The results (Table 1and 2) revealed that all the growth and yield traits were increased significantly by the application of polymers. Among the different doses of polymers, TerraCottem 4.5g, Polyvinyl alcohol 15.0g and Polyacrylamide 10.0 g per plant showed increased plant height, number of branches per plant, root length, root dry weight, fruit weight, fruits per plant, yield per plant, dry matter production and earliness in 50 per cent flowering. Similar results were obtained for plant height, root length and root dry weight in *Lingustum sp.,* (Taylor and Halfacre, 1986) for dry matter production and yield per plant in tomato and lettuce (Wallace, 1986 and; Wallace and Wallace,1986).

The enhancement of plant height due to polymers, which is supplied optimally, observed in the present study, also confirms the findings of Boutrous *et.al.(*1987) in sour orange and Dhumal (1993)in tomato. The least plant height with supply of inadequate polymers (T1 to T3,T7 to T10 and T13 to T15) might be the result of negative effect of moisture stress on cell division and elongation as observed by Huang(1978) in tomato that the moisture stress caused dehydration of protoplasm, which is associated with loss of turgor and reduction in the expansion of cells and cell division. These events might have decreased the growth of stem and in turn plant height in this study. The increase of plant height could be attributed to the elongation of internodes due to the proper supply of water and nutrients (Randhawa *et. al.,* 1981 and Singh *et. al.,* 1982). Which were enabled by the polymers,which releases moisture as and when the plant warrants.

Dhumal (1993) in chilli and Orzolek(1993) in chrysanthemum observed an increase in plant height, braches per plant, early flowering,fruits per plant and dry matter production. The increase in number of branches, number of fruits and dry matter production might be due to increased meristematic activity and increased supply of photosynthates owing to proper supply of nitrogen as stored in polymer along with water (Meyer *et. al.,* 1973). An extensive root system comprising of better root length and root dry weight in the presence of optimum doses of polymers was due to the favourable and promotive effect of optimum doses of polymers helped the uptake of soil available nitrogen in enhancing the root length (Wang,1989).Which could be explained on the basis of nitrogen-based growth through increase in plant height and branches per plant, concomitantly enhancing the photosynthetic activity. This would have resulted in production of more photosynthetes and translocation to roots, thus increasing the root length and dry weight (Singh *et.al.*1982).

These results could also be ascribed to the application of optimum doses of hydrophilic polymers which maintains optimal soil moisture helped biological nitrogen fixation and simultaneous conversion of insoluble phosphorus in the soil to the available form by conversion of acids, besides the production of hormones. This might have induced better root morphology leading to better translocation and assimilation of nutrients, in turn giving the best growth and yield.(Summer,1990)

Table 1.Efficacy of graded doses of hydrophilic polymers on morphological traits in tomato

Treatments	Plant height (cm)	No.of branches per plant	Days to 50% flowering	Root length (cm)	Root dry weight(g)
T_1.	73.2 ^{fg}	11.9 ^{f}	60.5 ^{a}	27.0 ^{cd}	16.5 ^{de}
T_2	78.7 ^{bc}	13.3 ^{d}	60.6 ^{a}	37.0 ^{ab}	18.7 ^{bc}
T_3	80.7 ^{a}	14.6 ^{ab}	55.7 ^{bc}	40.7 ^{a}	21.7 ^{a}
T_4	78.9 ^{bc}	14.6 ^{ab}	55.6 ^{bc}	40.4 ^{a}	21.0 ^{a}
T_5	80.2 ^{ab}	14.6 ^{ab}	57.4 ^{bc}	40.3 ^{a}	21.3 ^{a}
T_6	80.3 ^{ab}	14.3 ^{ab}	55.4 ^{bc}	31.5 ^{bc}	21.3 ^{a}
T_7.	80.0 ^{b}	10.3 ^{i}	61.2 ^{a}	26.4 ^{cd}	14.0 ^{f}
T_8 .	74.9 ^{de}	11.0 ^{gh}	61.3 ^{a}	26.1 ^{cd}	15.1 ^{ef}
T_9	76.6 ^{d}	11.0 ^{gh}	60.3 ^{a}	33.9 ^{ab}	16.4 ^{de}
T_{10}	78.4 ^{c}	12.3 ^{e}	55.8 ^{c}	35.7 ^{ab}	18.5 ^{cd}
T_{11}	79.7 ^{abc}	14.0 ^{bc}	55.8 ^{c}	37.6 ^{ab}	21.8 ^{a}
T_{12}	79.6 ^{abc}	13.8 ^{c}	53.0 ^{d}	37.5 ^{ab}	21.7 ^{a}
T_{13}	72.9 ^{g}	10.7 ^{hi}	60.4 ^{a}	26.8 ^{cd}	15.2 ^{f}
T_{14}	74.4 ^{ef}	11.4 ^{g}	60.3 ^{a}	30.5 ^{bc}	15.3 ^{ef}
T_{15}	78.9 ^{bc}	13.0 ^{d}	60.9 ^{a}	34.1 ^{ab}	17.0 $^{cd-f}$
T_{16}	80.3 ^{ab}	14.6 ^{a}	57.2 ^{ab}	37.9 ^{ab}	21.2 ^{a}
T_{17}	80.3 ^{ab}	14.3 ^{ab}	56.4 ^{c}	36.4 ^{ab}	20.9 ^{a}
T_{18}	80.3 ^{ab}	14.2 ^{abc}	56.0 ^{cd}	37.8 ^{ab}	20.7 ^{ab}
T_{19}	64.4 ^{i}	08.0 ^{a}	59.9 ^{ab}	23.4 ^{d}	10.5 ^{g}
Mean	**77.0**	**12.8**	**57.9**	**33.7**	**18.4**

In a column, means followed by a common letter (s) are not significantly different at 5 per cent level by DMRT.

Table 2 Efficacy of graded doses of hydrophilic polymers on yield traits in tomato

Treatments	Fruits per plant	Fruit weight (g)	Yield per plant (kg)	Dry matter production (g)
T_1.	14.9 ^{de}	42.9 ^{abc}	0.535 ^{d}	40.2 ^{d}
T_2	17.1 ^{bc}	43.4 ^{abc}	0.676 ^{c}	46.2 ^{bc}
T_3	19.4 ^{a}	45.3 ^{a}	0.854 ^{a}	50.7 ^{a}
T_4	19.0 ^{a}	45.2 ^{a}	0.823 ^{ab}	48.7 ^{ab}
T_5	19.3 ^{a}	44.8 ^{a}	0.850 ^{a}	50.0 ^{a}
T_6	19.2 ^{a}	45.3 ^{a}	0.851 ^{a}	49.8 ^{a}
T_7.	13.2 ^{f}	32.4 ^{f}	0.434 ^{f}	33.3 ^{efg}
T_8 .	13.9 ^{ef}	31.7 ^{f}	0.450 ^{e}	35.5 ^{e}
T_9	14.5 ^{def}	35.8 ^{e}	0.507 ^{d}	38.8 ^{d}
T_{10}	17.0 ^{bc}	41.5 ^{c}	0.656 ^{c}	44.6 ^{c}
T_{11}	18.8 ^{a}	45.2 ^{a}	0.831 ^{ab}	50.4 ^{a}
T_{12}	18.5 ^{ab}	45.2 ^{a}	0.825 ^{ab}	49.9 ^{a}
T_{13}	13.5 ^{ef}	35.2 ^{e}	0.459 ^{ab}	31.8 ^{fg}
T_{14}	13.8 ^{ef}	38.0 ^{d}	0.516 ^{e}	34.0 ^{efg}
T_{15}	15.6 ^{cd}	41.7 ^{bc}	0.647 ^{d}	34.6 ^{ef}
T_{16}	18.6 ^{ab}	44.0 ^{ab}	0.812 ^{c}	49.8 ^{a}
T_{17}	18.5 ^{ab}	43.1 ^{abc}	0.800 ^{ab}	49.5 ^{ab}
T_{18}	18.3 ^{ab}	43.6 ^{abc}	0.806 ^{ab}	49.0 ^{ab}
T_{19}	12.8 ^{f}	31.3 ^{f}	0.394 ^{f}	30.7 ^{g}
Mean	**16.6**	**40.8** ^{f}	**0.669** ^{f}	**43.0** ^{f}

In a column, means followed by a common letter (s) are not significantly different at 5 per cent level by DMRT.

The general improvement in growth and yield traits due to the gel forming hydrophilic polymers might be the result of favourable effects on water holding capacity of soil and its physical conditions such as bulk density, porosity and cation exchange capacity leading to improved nutritional status of soil (Al-Harbi *et.al.,*1996 and Azzam, 1983), which in turn increased the growth of tomato. The results were on par with higher doses of respective polymers. The soil pH is the function of soil reaction based on the soluble salts,which is optimized by the application of optimum doses of hydrophilic polymers (Wang,1989).The best growth of plants was obtained due to this optimization of pH with TerraCottem 4.5g plant $-^{1}$ (T3), Polyvinyl alcohol 15.0g plant^{-1} (T_{11}) and Polyacrylamide 10.0g plant^{-1} (T_{16}) .These results are in accordance with that of Taylor and Halfcre(1986) who noted that in the presence of hydrophilic polymers ,soluble salts were lowered to the extent of 20-37 per cent ,which in turn increased fertility over non-polymer check.

The effect was further enhanced by the supply of optimum doses of hydrophilic polymers (Wallace and Wallace 1986) ,possibly due to improved Ca status of soil. This could have resulted in improvement of pore space and reduction in bulk density, leading to rapid leaching of salts, with simultaneous in crease in Ca level and ultimately decreased sodicity and increased the yield in tomato. The polymer, as a chelating agent prevents reversal of the exchange of mass action and prevention of leaching by the polymer thus improves CEC by maintaining the nutrients even at increased salt concentration.

It could be seen that optimum doses of hydrophilic polymers gave the best results on hydraulic conductivity, which is a function of pore volume and pore space, longer pores being associated with greater conductivity(Mitchell,1986).Though soil organic matter serves to bind or cement clay particles together, so that the effective average particle size is larger. Hydrophilic polymers, a long chain organic compound have the ability to bind clay particles ztogether and form aggregates. This is what organic matter also does, but a small quantity of hydrophilic polymer would accomplish the same amount of aggregation that a large quantity of organic matter would do (Wallace and Wallace,1986) Thus the improvements in physical properties with respect to soil health on application of optimal doses of hydrophilic polymers would have contributed the best growth and yield .

Out of the 18 treatments tested for standardizing three polymers the polymers namely, TerraCottem 4.5g plant $-^{1}$ (T3), Polyvinyl alcohol 15.0g plant^{-1} (T_{11}) and Polyacrylamide 10.0g plant^{-1} (T_{16}) were standardized and recommended for further study.The optimum standardized doses helped to improve the plant height, branches per plant, root length, root dry weight, fruits per plant, fruit weight, yield per plant and dry matter production. The results were on par with higher dose of polymers away from the root zone leading to the wastage of water and nutrients from such polymers (Still, 1976 and Azzam, 1980).

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