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EFFECT OF HYDROPHILIC POLYMERS ON YIELD AND QUALITY OF TOMATO

S. Sendur Kumaran
Associate Professor and Head, Krishi Vigyan Kendra, Kundrakudi-630 206, Tamil Nadu, India

ABSTRACT

Low rainfall and scarcity of irrigation water severely affect cultivation of vegetables. Therefore, efficient utilization of limited water for the best crop growth and development is of great concern. The hydrophilic polymers are regularly supplying water to the plant based on its need and are greater use in storing water about 100-300 times of their own weight. They can play a vital role in stress alleviation at appropriate time as needed by the plants. Hence this study was undertaken to assess the efficacy of hydrophilic polymers severally and in combination with organic and inorganic fertilizers on growth, yield and quality of tomato cv. CO3. The results revealed that the application of polymer TerraCottem 4.5 g per plant with recommended dose of manures and fertilizers (FYM 25 t + NPK 150: 100:50 kg + Azospirillium 2kg + Phosphobacteria 2 kg ha-^{1}) followed by Polyvinyl alcohol 15.0 g per plant with recommended dose of manures and fertilizers improved the growth, yield and quality of rain fed tomato .

Key words: Tomato, hydrophilic polymers, growth, yield and quality, rain fed situation.

I. INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is obviously the most important vegetable grown, throughtout the world. It tops the list of industrial crops because of its outstanding processing qualities. The production and productivity of tomato is highly seasonal and it is a scarce commodity during summer. The situation under rain fed, the yield (Lal *et. al.,* 1991) and quality (Naphade, 1993) of tomato are limited by the availability of nutrients and water. The amount and frequency of irrigation, especially in regions with scanty rainfall or in areas where the irrigation water is scarce could be reduced with the use of hydrophilic polymers. These hydrophilic polymers can absorb water, as much as several hundred times their weight (Wallace and Wallace, 1986). The information available on combined use of polymers, with organic and inorganic fertilizers is scanty nevertheless; the beneficial effects of polymers have been studied worldwide in many horticultural crops including vegetables.

The application of hydrophilic polymers along with fertilizer recommendation based on the available soil resources would provide additional information on their effects on growth, yield and quality, and help suggest a suitable polymer-cum-fertilizer recommendation for rain fed cultivation of tomato. With this Knowledge, the effects of hydrophilic polymers individually and in combination with organic and inorganic fertilizers on growth, yield and quality of tomato cv. CO 3 were studied.

II. MATERIALS AND METHODS

The hydrophilic polymers which are commercially available *viz.,* TerraCottem (Terra Cottem International, Belgium), Polyvinyl alcohol (Aquatrols crop of America, USA) and Polyacrylamide (Viterras, Germany) were selected for the study and used as soil amendments for tomato grown under rain fed situations. The tomato cv. CO 3 used in this study is a determinate growth type,

drought tolerant, and cluster bearing with duration of 100-120 days. Fruits are round in shape with four light grooves and capsicum red in colour.The field experiments were conducted in sandy loam soil at the college orchard, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu state, India which is situated at 11^0 N latitude and 77^0 E longitudes and at an altitude of 426.26 m above mean sea level.

Under a simulated rain fed situation, the effect of hydrophilic polymers was studied. Ridges and furrows were formed in the field after a thorough ploughing. The gross plot size of 3.9 X 2.8 m^2 and the net plot size of 3.3 X 2.0 m^2 were adopted. The seedlings were raised in seedbeds and 25-day – old seedlings were planted in the main field. The spacing followed was 45 and 30 cm between rows and plants respectively. The hydrophilic polymers were applied to individual plants just before planting at a depth of 15 cm. The rain fed situation was simulated by irrigating to field capacity and withholding irrigation till the soil moisture was depleted to 25 per cent of available soil moisture (Dastane, 1972).

The soil moisture content was estimated periodically by thermo- gravimetric method (A.O.A.C., 1975). The field experiments were laid out in a randomized block design with 11 treatments involving the optimum does of polymers and recommended doses of organic and inorganic fertilizers, which was replicated thrice.

Treatment details

Number	Nature of Treatment
T_1	Terra Cottem 4.5 g Plant-1
T_2	Polyvinyl alcohol 15.9 g plant-1
T_3	Polyacrylamide 10.0 g plant-1
T_4	Recommended dose (RD) – FYM24t +NPK 150:100:50 kg +Azospirillium 2 kg + Phosphobacteria 2 kg ha-1)
T_5	RD + TerraCottem 4.5 g plant-1
T_6	RD +Polyvinylalcohol15.0g plant-1
T_7	RD +polyacrylamide 10.0 g plant-1
T_8	Organic manure (OM) – FYM 25 t +Neem Cake 250 kg +Azospirillium 2 kg + Phosphobacteria 2 kg ha-1
T_9	OM +Terra Cottem 4.5 g plant-1
T_{10}	OM +Polyvinylalcohol 15.0 g plant-1
T_{11}	OM +Polyacrylamide 10.0 g plant-1

In each replication five plants were selected randomly and utilized for recording observations on days to 50 per cent flowering ,plant height (cm), fruits per plant, fruit weight(g), yield per plant (kg), root dry weight(g), flesh thickness (cm), total soluble solid (TSS, ^{0} Brix), ascorbic acid (mg $100g^1$), Lycopene (mg $100g^{-1}$) and Shelf life (days).

III. RESULTS AND DICUSSION

The effect of hydrophilic polymers on growth and yield of tomato are presented in table1.The days to 50 per cent flowering, plant height, fruits per plant, fruit weight and root dry weight are important contributors towards the economic yield. This is made possible by the advancement in managerial practices like proper supply of water (Lal et. al., 1991), use of fertilizers and conditioning physical properties of soil (Wallace and Wallace, 1986).Tomato, being a fruit vegetable, responds well to the fertilizers and physio-chemical properties of the soil (Subbiah and Rani Perumal, 1986).

The present study revealed that the application of hydrophilic polymers combined with organic and inorganic fertilizers enhanced earliness in 50 per cent flowering, plant height, fruit per

plant, fruit weight, and root dry weight (Table 1). The synergistic effect of polymer and fertilizers was most evident with enhancement of growth and yield parameters. The effect was more pronounced in the combination of TerraCottem 4.5g and recommended dose of fertilizers (T,) followed by T_6 which received Polyvinyl alcohol 15.0g and recommended does of fertilizers. These treatments were on par for most of the characters studied (Table 1).

Table 1 Efficacy of hydrophilic polymers on growth and yield of tomato

Treatments	Days to 50% flowering	Plant height (cm)	Fruits per plant	Fruit weight (g)	Yield per plant (kg)	Root dry weight (g)
T_1	51.4 ^{e}	75.2^{bc}	14.2 ^{cd}	36.4 ^{def}	32.2 ^{e}	14.3 ^{de}
T_2	56.4 ^{bc}	65.4^{f}	14.7 ^{d}	36.2 ^{ef}	31.9 ^{f}	13.7 ^{e}
T_3	60.9 ^{a}	65.5^{f}	14.4 ^{d}	32.4 ^{gh}	29.9 ^{g}	13.5 ^{e}
T_4	55.5 ^{bcd}	68.1 e	13.0 ^{e}	34.2 ^{g}	25.1 ^{h}	14.2 ^{de}
T_5	47.6 ^{f}	80.1 ^{a}	19.2 ^{a}	45.4 ^{a}	49.2 ^{a}	22.4 ^{a}
T_6	51.7 ^{e}	75.6 ^{b}	18.2 ^{ab}	43.5 ^{ab}	45.7 ^{b}	20.3 ^{b}
T_7	55.2 ^{cd}	70.9^{d}	17.8 ^{abc}	36.4 ^{d}	34.9 ^{d}	13.1 ^{e}
T_8	57.5 ^{ab}	63.3 ^{g}	11.1 ^{f}	31.5 ^{h}	20.9 ^{i}	10.3 ^{f}
T_9	49.3 ^{f}	74.3^{bc}	17.8 ^{abc}	41.1 ^{bc}	41.9 ^{c}	18.4 ^{c}
T_{10}	54.1 ^{d}	73.5^{c}	17.3 ^{bc}	40.8 ^{c}	41.0 ^{c}	15.8 ^{d}
T_{11}	59.2 ^{ba}	70.3 ^{d}	14.9 ^{d}	34.7 ^{fg}	32.7 ^{f}	12.3 ^{e}
Mean	**54.3**	**71.1**	**16.4**	**37.9**	**37.5**	**15.3**

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

Usually water deficits manifest many anatomical changes in the plant like decrease in cell size and inter cellular spaces, thick cell wall and greater development of mechanical tissues by limiting cell division and elongation resulting in overall decrease of plant growth and yield (May and Milthrope,1962). Whereas, the results of the present study gain support from the earlier findings in tomato by Tomar (1997).The increased growth and yield components associated with adequate moisture status might be due to better vegetative growth as a result of increased water supply from the hydrophilic polymers, which would have increased the cell turgor leading to effective absorption and utilization of nutrients such as nitrogen, phosphorus and potassium. This might have caused better physiological process in cell division and elongation resulting in quick growth (Baluswamy *et. al.,* 1986).The increase in plant height and yield could be possible by the polymer –absorbed nitrogen (along with water),which is the chief constituent of protein,essential for the formation of protoplasm that leads to cell division and cell elongation .Moreover, nitrogen is an important component of amino acids and co-enzymes,which are of considerable importance (Singh *et.al.,*1982).

The results of the experiment done by Deka *et.al.,* (1994) in tomato clearly indicated the possibility of obtaining increased growth and yield due to the pivotal role played by nitrogen, phosphorus and potassium with *Azospirillium* and Phosphobacteria with the help of soil conditioners. It was demonstrated that nitrogen is an important nutrient to be essential for augmenting cell division and cell elongation, which in turn increase vegetative growth and thereby boosting the yield (Doss *et. al.,* 1981).According to Deka *et. al.,* 1994, the increased yield components should have strong association with increased the cell turgor leading to effective absorption of nutrients which in turn

cause proper cell division and elongation resulting in quick growth and yield. Similarly phosphorous, reported to be very essential for root proliferation, could have resulted in increased root dry weight and contributed to better plant morphology and earliness in flowering.

The other important nutrient potassium with its role on mobilization of photosynthates to the reproductive parts might have increased yield and quality (Deka *et. al.,* 1994).These results might be the outcome of improvement in polymer – induced water holding capacity in the root zone resulting in better availability of moisture and nutrients to the plants under water stress or a continuous and steady supply of moisture under normal conditions.

In the present study, the fruits per plant and fruit weight were increased with the application of TerraCottem 4.5g and recommended dose of fertilizers (T_5), which was statistically on par with Polyvinyl alcohol 15.0g and recommended dose of fertilizers (T_6) and TerraCottem 4.5g and organic manure (T_9), (Table1). The possible reason for increased fruit weight and fruits per plant could have resulted from higher uptake of nitrogen (Lata and Singh, 1993). The increase in plant height and branches per plant due to nitrogen would have helped formation of more leaf area and it is directly involved in the production of increased photosynthates. The photosynthates would have been effectively utilized for producing more fruits and their weight (Gill *et al.,* 1974), leading to an increase in yield per plant in tomato.

The results on the effect of hydrophilic polymers on quality of tomato are presented in table 2. Considering the quality parameters, a marked increase in flesh thickness, Total Soluble Solids, Ascorbic acid and lycopene was observed at TerraCottem 4.5g with organic manure and TerraCottem 4.5g with recommended dose of manures and fertilizers (Table 2). The increases in quality due to application of nitrogen and phosphorus (Murugan, 1990) and potassium (Nandagopalan, 1985), could be attributed to the enhanced photosynthetic and metabolic activities, which result in the synthesis of high amounts of acids, metabolites and glucose. These reserves, thus produced might have contributed to the native synthesis of Total Soluble Solids and Ascorbic acid.

Table 2 Efficacy of hydrophilic polymers on quality of tomato

Treatments	Flesh thickness (cm)	Total Soluble Solids (^{0}Brix)	Ascorbic acid (mg 100g^{-1})	Lycopene (mg 100g^{-1})	Shelf life (days)
T_1	0.35 ^{c}	3.53^{cd}	25.8 ^{abc}	4.45 ^{def}	9.4 ^{g}
T_2	0.34 ^{c}	3.36 ^{f}	25.1 ^{de}	4.26 ^{ef}	8.9 ^{gh}
T_3	0.33 ^{c}	3.34 ^{f}	24.6 ^{e}	4.24 ^{f}	8.6 ^{h}
T_4	0.35 ^{c}	3.45 ^{def}	25.7 $^{a-d}$	4.40 ^{def}	9.9 ^{fg}
T_5	0.43 ^{a}	3.68 ^{ab}	26.3 ^{a}	5.17 ^{ab}	13.2 ^{ab}
T_6	0.38 ^{b}	3.58 ^{bc}	26.2 ^{a}	4.67 ^{cd}	12.6 ^{bc}
T_7	0.34 ^{c}	3.52 ^{cde}	25.3 ^{cd}	4.38 ^{def}	11.5 ^{e}
T_8	0.37 ^{b}	3.56 ^{cd}	25.9 ^{ab}	4.56 ^{de}	10.1 ^{fg}
T_9	0.42 ^{a}	3.69 ^{a}	26.3 ^{a}	5.30 ^{a}	13.3 ^{a}
T_{10}	0.39 ^{b}	3.59 ^{bc}	26.2 ^{a}	4.92 ^{bc}	12.9 ^{ab}
T_{11}	0.35 ^{c}	3.41 ^{ef}	25.4 ^{bcd}	4.38 ^{def}	10.7 ^{f}
Mean	**0.37**	**3.53**	**25.7**	**4.59**	**11.4**

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

Tomato, being a perishable commodity, shelf life is considered important for storage and marketing. The shelf life was influenced by different treatments in the present study. It is obvious from the results that TerraCottem 4.5g with organics improved the shelf life. The effects of both polymer and organic manures would have helped stabilize the physico-chemical properties of the soil (Wallace and Wallace, 1986) and thereby improving the quality of tomato as observed from this investigation.

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