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Mulching and fertigation on the yield and quality of tomato

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Abstract
A field experiment was conducted at irrigation cafeteria, Water Technology Centre, Tamil Nadu Agricultural University to study the effect mulching and humic acid in the yield, quality of tomato under fertigation and fertility of soil with twelve treatments. The study revealed that application of 100% R D F + B M + H A @ 20 kg ha^{-1} as basal had a greater potential for improving the nutritional quality characters of tomato fruits such as total soluble solids, titratable acidity, ascorbic acid and lycopene and yield were increased markedly. Application of 100% recommended dose of fertilizers + Black color mulching increased the nutritional quality characters of tomato fruits and yield than 100% recommended dose of fertilizers alone.

Keywords: Tomato, fertigation, mulching, humic acid

Introduction
Tomato (*Lycopersicon esculentum* Mill.) is one of the popular vegetables in the world, ranking second in importance next to potato. It ranks first among the processed vegetables grown all over the world. Tomato otherwise called as 'Love apple' or Golden apple' or 'Poor man's apple' is one, which has attained world wide importance. It is a good source of vitamin A, C and potassium. Lycopene pigment imparts red color and is a potential anti-oxidant for minimizing the damage caused by free radicals.

It is popularly grown throughout India and the major tomato producing states are Maharashtra, Bihar, Karnataka, Tamil Nadu, Uttar Pradesh, Orissa, Andhra Pradesh, Madhya Pradesh and Assam. Our national production of tomato is 16826400 Mt from an area of about 864900 ha with an average productivity of 19.5 Mt ha^{-1}. In Tamil Nadu, production of tomato is 580600 Mt from an area of about 27200 ha with an average productivity of 21.4 Mt ha^{-1} (Indian Horticulture Database, 2011) [3].

The advent of increasing water scarcity in this century will observe less increase in irrigated land availability for food production than in the past. Novel irrigation technologies need to be tested under local environments and particularly in agricultural production systems of developing countries. Drip irrigation helps in maintaining optimum soil moisture in the root zone with increased yield and water use efficiency. A significant goal in soil fertility research is to develop practices by which crop nutrient requirements are satisfied through maximum uptake of nutrients from minimum quantity of applied fertilizers.

India is the third fertilizer producing and consuming country in the world. The nutrient consumption per hectare and fertilizer use efficiency is very low in India. The main reasons for low efficiency are the type of fertilizer used and its method of application adopted by Indian farmers. Hence, there is a need to develop a suitable method of application of fertilizer, which will improve the quantity and quality of crop production. Fertigation is the process of application of water soluble solid fertilizers or liquid fertilizers through drip irrigation system. Through fertigation, nutrients are applied directly into the wetted volume of soil immediately below the emitter, where root activity is concentrated. Fertigation is possible only in drip irrigation.

Drip fertigation in combination with mulch is one of the best management option, which can improve the water management practice significantly. Surface mulches have been used to improve soil water retention, reduce soil temperature, soil erosion, reduce wind velocity at the soil surface and arid lands. Surface mulches can also improve water penetration by impeding runoff and protecting the soil from rain drop splash and reducing soil crusting. Plastic mulches are commonly used in the production of vegetables. Black plastic mulch, the predominant

color used in crop production, is an opaque black body absorber and radiator (Aniekwe *et al.*, 2004) [1].

Soil health is a crucial factor for realizing higher yield of vegetables. Chemical fertilizers along with organic manure will ensure soil health and sustainable productivity. Humic acid influences plant growth through modifying the physiology of plants and by improving the physical, chemical and biological properties of soil. Humic acid is reported to increase the permeability of plant membranes resulting in higher metabolic activity. As a factor of improving physical properties of soil, it promotes good soil structure, there by improves tilth, aeration and moisture retention. Its chemical function is manifested by its higher cation exchange capacity. Humic acid provides carbon as an energy source to nitrogen fixing bacteria and thus proves its biological function.

Materials and Methods

A field experiment was conducted at irrigation cafeteria, WTC, TNAU, Coimbatore, in soil representing *Isohyperthermic Vertic* U*stropept*, [sandy clay loam in texture,, pH 7.54, EC 0.72 dS m^{-1}, low in available N (228 kg ha^{-1}), medium in available P (18 kg ha-1), high in available K (525 kg ha^{-1})] in RBD with three replications and twelve treatments. Treatments receiving 100 per cent recommended dose of fertilizers were supplied through Fertigation system with calculated quantities of fertilizers containing N, P and K to supply 50:300:50 kg ha^{-1} of N, P_2O_5, K_2O as basal N and K_2O each 150 kg ha^{-1} in equal splits at various crop growth stages after transplanting. Similarly, fertilizers containing 150:225:150 kg ha^{-1} of N, P_2O_5, K_2O were applied through the Fertigation system to treatments receiving 75 per cent recommended dose of NPK fertilizers. Soil application of humic acid @ 20 kg ha^{-1} was also applied the basal soil application. Foliar spraying of humic acid @ 0.1 per cent was done on 30, 45 and 60 day after transplanting.

Treatment details

T. No	Treatment details
T1	Absolute Control
T2	100 % RDF Through Fertigation
T3	100 % RDF Through Fertigation + Black polythene mulching + Humic acid @20 kg ha^{-1} as basal
T4	100 % RDF Through Fertigation + Grey polythene mulching + Humic acid @20 kg ha^{-1} as basal
T5	75 % RDF Through Fertigation + Black polythene mulching + Humic acid @20 kg ha^{-1} as basal
T6	75 % RDF Through Fertigation + Grey polythene mulching + Humic acid @20 kg ha^{-1} as basal
T7	100 % RDF Through Fertigation+ Black polythene mulching + Foliar application of humic acid @0.1 % @ 30, 45 and 60 DAT
T8	100 % RDF Through Fertigation+ Grey polythene mulching + Foliar application of humic acid @0.1 % @ 30, 45 and 60 DAT
T9	75 % RDF Through Fertigation+ Black polythene mulching + Foliar application of humic acid @0.1 % @ 30, 45 and 60 DAT
T10	75% RDF Through Fertigation+ Grey polythene mulching + Foliar application of humic acid @0.1 % @ 30, 45 and 60 DAT
T11	100 % RDF Through Fertigation + Black polythene mulching
T12	75% RDF Through Fertigation + polythene Grey mulching

RDF- Recommended dose fertilizer, DAT- Days after transplanting

During vegetative stage the fertilizer was applied at weekly intervals. During flowering stage the fertilizer was applied at three days intervals and during fruiting stage it was applied again at weekly intervals. The total quantity of fertilizers required to fertigation were 177, 660 and 400 kg ha^{-1} respectively for urea, DAP and Sulfate of potash.

Fruit samples were analysed for quality parameters like total soluble solids, titrable acidity, ascorbic acid and lycopene content following standard procedures.

Results and Discussion

Total soluble solids

The highest total soluble solids of 5.81 per cent was recorded in the treatment receiving application of 100% recommended dose of fertilizer + black colour polythene mulching + humic acid @ 20 kg ha^{-1} as basal (Table 1). Contreras *et al*. (2000) [2] reported that fertigation increased total soluble solids and titrable acidity in tomato. The increased TSS may be due to increased carbohydrate production during photosynthesis. The higher potassium content of plant which enhances the translocation of assimilated sugars from leaves into fruits might be the key factor for the higher TSS of fruits.

Titratable acidity (TA)

Application of 100% recommended dose of fertilizer + black colour polythene mulching + humic acid @ 20 kg ha^{-1} as basal recorded the highest TA of 0.71 per cent (Table 1). Fertigation, mulching and humic acid appreciably increased the TA of fruits.

Ascorbic acid

Application of 100% recommended dose of fertilizer + black color mulching + humic acid @ 20 kg ha^{-1} as basal recorded the highest ascorbic acid content of 31.42 mg 100 g^{-1} (Table 1). Kaviani *et al.* (2004) recorded higher ascorbic acid content (38 mg 100 g^{-1}) when K was applied by fertigation with SOP than soil application of KCl in tomato. Increased amount of vitamin C in chilli fruit was observed in all the mulch treated plants compared to control. But among the mulch treatments, there was no significant difference in vitamin C content of the fruits.

Lycopene

Application of 100% recommended dose of fertilizer + black color mulching + humic acid @ 20 kg ha^{-1} as basal recorded the highest lycopene content of 6.28 mg 100 g^{-1} (Table 1). The possible reason for increased lycopene content is the higher concentration of chloroplasts resulting from humic acid application which acts as the site of lycopene synthesis during fruit ripening.

Fruit Yield

Application of 100% recommended dose of fertilizer + black color mulching + humic acid @ 20 kg ha^{-1} as basal recorded the highest tomato yield of 98.99 t ha^{-1} (Table1). The lowest value was recorded in absolute control (63.57 t ha^{-1}). Application of 100% recommended dose of fertilizers + Black colour polythene mulching increased the nutritional quality characters of tomato fruits and yield than 100% recommended dose of fertilizers alone. Fertigation increased the Nutrient use

efficiency and nutrient availability in soil besides enhance the uptake of nutrient and increase the tomato growth and yield attributes, it's leads to increased the tomato yield. Mulch ameliorated the hydrothermal regime of the soil, improved vegetative and lowering performance and significantly increased fruit yield of tomato over bare ground. Addition of humic acid released nutrients in a slow but steady manner. Humic acid causes consistent regulation of nutrient availability during fruit development, when the uptake of nutrients is more important. Balanced nutrition of organic and inorganic nutrients maintains optimum ratio between the nutrients, which is of considerable importance in improving the yield.

In conclusion, a spectacular increased in total soluble solids, titrable acidity, ascorbic acid and lycopene content of fruits was observed in treatment receiving application of 100% recommended dose of fertilizer + black colour polythene mulching + humic acid @ 20 kg ha^{-1} as basal. Ultimately increased the tomato fruit yield by the application of 100% recommended dose of fertilizer + black color mulching + humic acid @ 20 kg ha^{-1} as basal.

Table 1: Effect of fertigation, mulching and humic acid on total soluble solids, titratable acidity, Ascorbic acid, lycopene and tomato yield

Treatments	TSS (per cent)	TA (per cent)	Ascorbic acid (mg 100 g^{-1})	Lycopene (mg 100 g^{-1})	Yield (tonnes ha^{-1})
T_1 - Absolute Control	4.48	0.47	24.34	3.930	63.57
T_2 - 100%RDF	4.75	0.51	26.85	4.040	74.88
T_3 - 100 % RDF + BM+ HA	5.81	0.71	31.42	6.280	98.99
T_4 - 100 % RDF + GM + HA	5.64	0.70	31.36	6.190	96.86
T_5 - 75 % RDF + BM + HA	5.52	0.67	30.98	5.920	94.95
T_6 - 75 % RDF + GM + HA	5.46	0.65	30.04	5.870	94.54
T_7 - 100% RDF + BM + HA*	5.43	0.63	29.64	5.620	89.85
T_8 - 100 % RDF + GM+ HA*	5.36	0.61	29.48	5.590	89.00
T_9 - 75 % RDF + BM + HA*	5.14	0.58	28.78	5.200	87.82
T_{10} - 75% RDF + GM + HA*	5.12	0.56	28.12	5.160	87.44
T_{11} - 100 % RDF + BM	5.07	0.57	27.95	4.950	76.66
T_{12} - 75% RDF + GM	4.77	0.52	27.23	4.610	75.37
S.Ed	0.25	0.03	1.368	0.263	4.00
CD(0.05)	0.52	0.06	2.837	0.546	8.30

RDF - Recommended dose of fertilizer through Fertigation, BM - Black mulching
GM- Grey mulching, HA- Humic acid @ 20 kg ha^{-1} as basal
HA*- Foliar application of humic acid @ 0.1 % @ 30, 45 & 60 DAT

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