Eco. Env. & Cons. 28 (January Suppl. Issue) : 2022; pp. (S382-S386)
Copyright@ EM International
ISSN 0971–765X

http://doi.org/10.53550/EEC.2022.v28i01s.054

Effect of nutrient ratios of Water Soluble Fertilizers on Quality of Tomato *(Solanum lycopersicum* L.) under fertigation

Minnu John[1*], M. Elayarajan[2], R. Swarna Priya[3] and P. Janaki[4]

[1]Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore 641 003, T.N., India
[2]Water Technology Centre, TNAU, Coimbatore 641 003, T.N., India
[3]Department of Vegetable Science, TNAU, Coimbatore-641 003, T.N., India
[4]Department of Soil Science & Agricultural Chemistry, TNAU, Coimbatore 641 003, T.N., India

(Received 1 August, 2021; Accepted 15 September, 2021)

ABSTRACT

A pot experiment was conducted during summer 2021 at the Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore to study the effect of nutrient ratios of water soluble fertilizers on the quality parameters of TNAU Tomato Hybrid CO 3 under fertigation. The experiment was laid out in Completely Randomized Design with nine treatments each replicated thrice. The results revealed that the different quality parameters *viz*., titratable acidity (1.16 % citric acid 100g^{-1}), lycopene (4.88 mg 100g^{-1}) and β carotene (0.88 mg 100g^{-1}) contents recorded highest values under fertigation with 1:1:1 NPK @ 100 % RDN + Ca + B while TSS (5.01°Brix) and ascorbic acid (46.6 mg 100g^{-1}) marked the highest under fertigation with 1:1:1 NPK @ 100% RDN + B. The lowest quality fruits were observed in the absolute control. This particular study revealed that the fertigated treatments enhanced the quality of fruits over the conventional methods of fertilization and the application of nitrogen, phosphorus and potassium alone won't result in better quality but, those together with calcium and boron through fertigation may result in the best quality parameters of tomato.

Key words: *Fertigation, Quality, Tomato, Water soluble fertilizer*

Introduction

Tomato, (*Solanum lycopersicum* L.), is undoubtedly crop of prime importance in the world. The millennial population is moving towards a healthier diet with quality products over unhealthy junk and the tomatoes serve the job. Owing to its richness in minerals, vitamins, especially vitamin 'C', carotenoids, antioxidants, and organic acids, tomatoes are consumed around the globe as fresh and processed products.

Tomato requires all the major nutrients and micronutrients like boron for its growth and development. Nitrogen (N) is essential for the vegetative growth of tomato, Phosphorus (P) for root development, flowering and fruiting, Potassium (K) for fruit quality. Formation of calcium pectate due to the binding of calcium (Ca) with pectins increases the strength of cell wall and middle lamella, thus increasing the firmness, reducing the physiological disorders, delaying ripening process and prolonging the shelf life of tomato which improves the fruit quality (Sharma *et al*., 1996; Carpita and McCann, 2000). Also inadequate Ca fertilization is thought to

([1]MSc Student, [2]Associate Prof., [3]Prof. and Head, [4]Associate Prof.)

be the main cause of blossom end rot in tomato fruits despite the influence of numerous environmental factors involved (Saure, 2001). Boron (B) prevents the fruit cracking and its deficiency reduces yield and quality in tomatoes (Davis *et al*., 2003). Thus the enhanced quality of tomatoes demands supplementary addition of N, P, K, Ca and B as amendments to the soil.

The application of essential nutrients through fertigation has led to improved fruit quality in crops like papaya (Jeyakumar *et al*., 2010) and strawberry (Kachwaya and Chandel, 2015). Besides being superior to the traditional methods, fertigation gives flexibility of fertilizer application precisely according to the plant's requirements because the fertigation schedule can be adjusted according to the crop needs.

Since tomato plants need nutrients even up to fruit ripening, split application of fertilizers, preferably at each critical stage of growth *viz*., vegetative, flowering, fruiting and harvest, through fertigation with water soluble fertilizers (WSF) can promote nutrient use efficiency and crop productivity eventually resulting in enhanced quality. With this background, the present experiment was conducted with the objective to study the effect of nutrient ratios of WSF on quality parameters of TNAU Tomato Hybrid CO 3 under fertigation in a pot experiment.

Materials and Methods

Location and Experiment Details

A pot experiment was conducted during summer of 2021 at Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University (TNAU), Coimbatore. The experimental location is geographically situated at 11° N latitude, 76° E longitude and at an altitude of 426.7m above the mean sea level. The experiment was laid out in a Completely Randomized Design in 54 pots, each filled with 12 kg soil and kept open. The experimental soil collected from the Horticulture Orchard of TNAU, Coimbatore had a clay loam texture with a bulk density of 1.42 Mg m^{-3}, soil reaction (pH) 8.54 (strongly alkaline), electrical conductivity (EC) 0.49 dSm^{-1}(medium salinity according to USSL), organic Carbon 6.6 g kg^{-1} (high), Available Nitrogen, Available Olsen Phosphorus, Available Potassium, exchangeable Calcium and available Boron (Hot water) of 327.4 $kgha^{-1}$(medium), 12.8 $kgha^{-1}$(medium), 273 $kgha^{-1}$(medium), 6.4 ppm (medium) and 0.48 ppm (medium) respectively.

One month old seedlings of semi determinate 'TNAU Tomato Hybrid CO 3', used as the test crop, rose in the shade house at the Horticulture Orchard, TNAU, Coimbatore, were transplanted to the pots after treating with Carbendazim.

The pot experiment comprised of nine treatments imposed in three replications. One treatment was kept as a control with application of the recommended dose of fertilizers (RDF) (200:250:250 NPK kg ha^{-1}) (Crop Production Guide (CPG), TNAU 2020), another treatment as absolute control without the addition of fertilizers and others with seven different combinations of WSF. WSF used as source of nitrogen were Urea, Mono Ammonium Phosphate (MAP), Calcium Nitrate and 19:19:19. Phosphorus sources were Single Super Phosphate (SSP), MAP and 19:19:19. Potassium was supplied through Muriate of Potash (MOP) and 19:19:19. Calcium and boron sources were Calcium Nitrate and Borax respectively. The treatments imposed were T_1- NPK Solid Fertilizers @ 200:250:250 kg ha^{-1} (100% RDF) through urea, SSP and MOP respectively, T_2- 1:1:1 NPK Fertigation @ 100% RDN + Basal P (Solid) @ 75% RDF through 19:19:19 and SSP respectively, T_3- 1:1:1 NPK Fertigation @ 100% RDN through 19:19:19 alone, T_4- 1:2:1 NPK Fertigation @ 100% RDN through urea, MAP and MOP, T_5- 2:1:1 NPK Fertigation @ 100% RDN through 19:19:19 and urea, T_6- 1:1:1 NPK Fertigation @ 100% RDN + Ca through 19:19:19, urea and calcium nitrate, T_7- 1:1:1 NPK Fertigation @ 100% RDN + B through 19:19:19 and borax, T_8- 1:1:1 NPK Fertigation @ 100% RDN + Ca + B through 19:19:19, calcium nitrate and borax, and T_9- Absolute Control. The amount of fertilizer to be applied to each pot at each stage of the plant growth was calculated according to the CPG, TNAU (2020), with emphasis on the recommended dose of nitrogen (RDN). Basal P @ 75% RDF was supplied as basal dose in all the treatments except T_3 and T_9. T_1 was supplied with solid fertilizers in conventional method and treatments T_2 to T_8 were fertigated four times with the WSF at 5, 15, 45, and 75 days after transplanting according to CPG,TNAU (2020) so that the sampling coincides with the critical stages of tomato plant growth (Table 1).

Analysis

The harvested tomato fruits were analysed in the Post Graduate Laboratory at Department of Soil Sci-

ence and Agricultural Chemistry, TNAU for various quality parameters. The pH of tomato juice was measured using an electronic pH meter. A hand-held refractometer (Erma Tokyo Hand Refractometer) was used to measure the Total Soluble Solids (TSS) level of the tomato fruits. The titratable acidity in the fruit sample was estimated according to the procedure in AOAC (1995). Ascorbic acid content was estimated using Dye titration method (Sadasivam and Manickam, 1992). Lycopene and β Carotene contents were estimated using petroleum ether extraction method (Ranganna, 1986).

Statistical Analysis

All the parameters were subjected to analysis of variance (ANOVA) and the data were analysed using AGRES Version 7.01 software. Fisher's Least Significant Difference (LSD) was used to test the significant differences between the means, at probability level P=0.05 using the ANOVA and considered statistically significant at 95% confidence.

Results and Discussion

Quality Parameters

TSS and Ascorbic Acid

Significant difference was observed among the treatments with respect to the TSS and ascorbic acid content of tomato fruit when B was also included in the fertigation schedule. Ascorbic acid content was recorded highest in the treatment fertigated with 1:1:1 NPK @100% RDN + B (T_7) and then in treatment fertigated with 1:1:1 NPK @100 % RDN + Ca + B (T_8). TSS content in treatment fertigated with 1:1:1 NPK @100% RDN + B (T_7) was significantly different from others and was the highest, followed by NPK 1:1:1 @100 % RDN + Ca + B (T8) and 1:1:1 NPK Fertigation @ 100% RDN+Ca (T6) both of which were significantly on par. Absolute control treatment had the significantly lowest TSS and ascorbic acid contents (Table 2). The highest TSS content in treatments fertigated with B along with NPK may be because B facilitates sugar transport within a plant, like from the leaves to the developing fruits, and it is reported that borate reacts with sugars to form a sugar-borate complex that is more easily available to the transverse membrane, resulting in increased fruit TSS (Gauch and Duggar, 1954; Negi *et al.*, 2010). Higher level of ascorbic acid with application of B may be due to higher sugar content in the fruit as ascorbic acid is synthesized from sugars (Talang *et al.*, 2016). Significant improvement in the ascorbic acid content in tomato by following B application was also reported by Jyolsna *et al*. (2008) where it was attributed to the possible catalytic function of B in converting sugars to vitamin C.

Lycopene and β-Carotene

Lycopene and β-carotene are the prominent carotenoids giving the colour to tomato fruits. Lycopene and β-carotene contents in the fruits harvested from plants fertigated with 1:1:1 NPK @100 % RDN + Ca + B (T_8) was significantly different from others and reported the highest. It was followed by fertigation with 1:1:1 NPK @ 100% RDN + Ca (T6). This might be due to continuous supply of the nutrients enabling better uptake, assimilation and thereby synthesis of lycopene and carotene. β-carotene may be synthesised from lycopene, indicating its increasing

Table 1. Total amount of nutrients supplied at critical growth stages based on CPG,TNAU (2020)

Treatments	Total amount of nutrients supplied per pot at critical growth stages				
	N(g)	P_2O_5(g)	K_2O (g)	Ca(mg)	B(mg)
T_1- Solid Fertilizers @ 100% RDF	2.31	8.30	2.21	-	-
T_2- 1:1:1 NPK Fertigation @ 100% RDN + Basal P (Solid) (75% RDF)	5.59	11.8	5.59	-	-
T_3- 1:1:1 NPK Fertigation @ 100% RDN	5.59	5.59	5.59	-	-
T_4- 1:2:1 NPK Fertigation @ 100% RDN	2.15	7.31	2.14	-	-
T_5- 2:1:1 NPK Fertigation @ 100% RDN	5.64	7.97	1.75	-	-
T_6- 1:1:1 NPK Fertigation @ 100% RDN+Ca	3.92	9.01	2.79	0.58	-
T_7- 1:1:1 NPK Fertigation @ 100% RDN+B	5.59	11.8	5.59	-	0.38
T_8- 1:1:1 NPK Fertigation @ 100% RDN+Ca+B	5.59	11.8	5.59	0.58	0.38
T_9- Absolute Control	-	-	-	-	-

Table 2: Effect of different ratios of WSF on the quality parameters of TNAU Tomato Hybrid CO 3.

Treatments	pH	Titratable Acidity (% citric acid 100g{1})	TSS (°Brix)	Ascorbic Acid (mg 100g {1})	Lycopene (mg 100g {1}) 100g{1})	â-Carotene (mg
T_1- Solid Fertilizers @ 100% RDF	4.20	0.87	3.80	35.4	3.76	0.65
T_2- 1:1:1 NPK Fertigation @ 100% RDN + Basal P (Solid) (75% RDF)	3.75	0.98	4.16	37.3	4.41	0.74
T_3- 1:1:1 NPK Fertigation @ 100% RDN	4.00	0.90	4.00	36.8	3.83	0.68
T_4- 1:2:1 NPK Fertigation @ 100% RDN	4.09	1.10	4.65	44.7	5.08	1.05
T_5- 2:1:1 NPK Fertigation @ 100% RDN	4.09	0.83	4.16	37.3	4.24	0.60
T_6- 1:1:1 NPK Fertigation @ 100% RDN + Ca	3.65	1.25	4.24	42.4	5.23	0.99
T_7- 1:1:1 NPK Fertigation @ 100% RDN + B	4.06	0.93	5.20	56.6	3.19	0.45
T_8- 1:1:1 NPK Fertigation @ 100% RDN + Ca + B	3.90	1.16	4.73	46.7	5.77	1.49
T_9- Absolute Control	3.43	0.68	3.79	27.1	2.53	0.24
SEd	0.06	0.23	0.07	0.92	0.11	0.03
CD (P=0.05)	0.12**	0.12**	0.15**	1.95**	0.24**	0.06**

concentration with that of lycopene. Similar results of increased lycopene and β-carotene in tomato was reported by Xu *et al.* (2021). Lowest Lycopene and β-carotene contents in the fruits were observed in the absolute control treatment

Fruit pH and Titratable Acidity

Higher fruit acidity or lower pH is a preferred quality in the post-harvest industry. The most acidic fruits were those produced in the treatment that received 1:1:1 NPK fertigation @ 100% RDN + Ca + B (T8). The pH was significantly lower in 1:1:1 NPK fertigation @ 100% RDN + Ca + B (T8) and the next lowest (3.56) in 1:1:1 NPK Fertigation @ 100% RDN+ Ca (T6). The highest pH was recorded in the absolute control (T9). The highest ascorbic acid content was found in the fruits of 1:1:1 NPK fertigation @ 100% RDN + B (T7). This treatment was followed by 1:1:1 NPK fertigation @ 100% RDN + Ca + B (T8) with an ascorbic acid content of 44.5 mg 100g-1 in its fruits. The minimum ascorbic acid content was recorded in the fruits of the absolute control (T9). The shift in biochemical reaction towards more sugar production can result in reduction in titratable acidity content for which Bhelps because of its role in sugar translocation in plants. Thus as the fruit ripe, acid content decrease and fruit pH increase.

The results of this particular experiment lead to the conclusion that the combination of Ca and B had a significant influence on the quality parameters of TNAU Tomato Hybrid CO 3. Increase in the overall fruit quality might be due to the better intake of nutrients when applied through fertigation with WSF when compared to the application of nutrients through conventional methods (Solid Fertilizers @ 200:250:250 kg NPK ha^{-1} (100% RDF)). Therefore, the application of Ca and B together with N, P and K at the right ratio at the right time through fertigation may be suggested after on farm testing for commercial cultivation of tomato to enhance the fruit quality.

Conflict of Interest

The authors declare that there is no conflict of interest.

References

AOAC. 1995. *Official Methods of Chemical Analysis.* Association of Official Analytical Chemists (AOAC) Arlington, Virginia, USA.

Carpita, N. and McCann, M. 2000. The plant cell wall. In: (Eds.): B. Buchanan, W. Gruissem and R. Jones. *Biochemistry & Molecular Biology of Plants*. American Society of Plant Physiologists, pp 52-109.

Davis, J. M., Sanders, D. C., Nelson, P. V., Lengnick, L. and Sperry, W. J. 2003. Boron improves growth, yield, quality, and nutrient content of tomato. *Journal of the American Society for Horticultural Science*. 128(3) : 441-446.

Guach, H.G. and Duggar, W.W. Jr. 1954. The physiological action of boron in higher plants: A review and interpretation. Univ. Maryland Agril. Expt'l. Stn. *Tech. Bull.* (A): 80

Jeyakumar, P., Amutha, R., Balamohan, T. N., Auxcilia, J., and Nalina, L. 2008, December. Fertigation improves fruit yield and quality of papaya. In: *II International Symposium on Papaya* 851 (pp. 369-376).

Jyolsna, V. K. and Mathew, U. 2008. Boron nutrition of to-

mato (Lycopersicon esculentum L.) grown in the laterite soils of Southern Kerala. *Journal of Tropical Agriculture*. 46 : 73-75.

Kachwaya, D. S. and Chandel, J. S. 2015. Effect of fertigation on growth, yield, fruit quality and leaf nutrients content of strawberry (Fragaria× ananassa) cv Chandler. *Indian Journal of Agricultural Sciences*. 85(10) : 1319-1323.

Negi, S. S., Singh, A. K. and Rai, P. N. 2010.Effect of foliar application of nutrients on pollen, flowering, fruit-set, fruit drop and yield in mango cv. Dashehari. *Horticultural Journal*. 23(2): 45-48.

Ranganna, S. 1986. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*.Tata McGraw-Hill Education.

Sadasivam, S. and Manickam, A. 1992. *Biochemical Methods for Agricultural Sciences*. Wiley eastern limited.

Saure, M.C. 2001. Blossom-end rot of tomato (*Lycopersicon esculentum* Mill.) – a calcium- or a stress-related disorder? *Sci. Hort*. 90 : 198-208.

Sharma, R.M., R. Yamdagni, H. Gaur and R.K. Shukla. 1996. Role of calcium in horticulture-a review. *Haryana J. Hort. Sci*. 25 : 205-212.

Talang, H. D., Dutta, P., Mukhim, C. and Patil, S. 2016. Effect of calcium, boron and sorbitol on fruit-set, yield and quality in mango cv. Himsagar. *Journal of Horticultural Sciences*. 11(2) : 166-169.

Xu, W., Wang, P., Yuan, L., Chen, X. and Hu, X. 2021. Effects of application methods of boron on tomato growth, fruit quality and flavor. *Horticulturae*. 7(8): 223.