Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2582-2845.8671

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2021) *9*(3), 1-6

Indian Journal of Pure & Applied Biosciences

Peer-Reviewed, Refereed, Open Access Journal

Research Article

Response of Cherry Tomato [*Solanum lycopersicum* L. var. *cerasiforme* (Dunnal) A. Gray] to Varied Levels of Nitrogen and Phosphorus Fertigation under Open Field and Polyhouse Conditions

Arshad Farooqi[1*], N. C. Narase Gowda[2] and Hafizullah Niazy[3]

[1]Department of Horticulture, Faculty of Agriculture, Baghlan University, Baghlan, Afghanistan

[2]Department of Horticulture, University of Agricultural Sciences, Bangalore, Karnataka, India

[3]Department of Horticulture, Faculty of Agriculture, Laghman University, Laghman, Afghanistan

*Corresponding Author E-mail: arshadfarooqi537@gmail.com

Received: 15.03.2021 | Revised: 19.04.2021 | Accepted: 29.04.2021

ABSTRACT

An investigation was carried out at the Department of Horticulture, University of Agricultural Sciences, Bangalore during summer-2017 to study the effect of varied levels of nitrogen and phosphorus fertigation on cherry tomato under open field and polyhouse conditions. There were 12 treatment combinations comprising of two growing conditions (open field and polyhouse), three levels of nitrogen (120, 150 and 180 kg N ha^{-1}) and two levels of phosphorus (100 and 120 kg P_2O_5 ha^{-1}) supplied trough fertigation with recommended potassium (150 kg h^{-1}) as constant which were laid out in Factorial Randomized Complete Block Design with three replications. Result revealed that plant height (384.39 cm), fresh weight per plant (3.00 kg), nitrogen balance index (48.56), total leaf area per plant (6293 cm^2), mean fruit weight (15.84 g), TSS content (6.30 ºB) and shelf life (15.66 days) were significantly higher under polyhouse condition with fertigation level of 180:120 kg N:P_2O_5 ha^{-1}. However, significantly higher yield per hectare (78.16 t), Shelf life (15.66 days) and higher cost benefit ratio (4.81) were observed under open field condition with fertigation level of 150:120 kg N: P_2O_5 ha^{-1}. Further, it can be concluded from the study that application of 150:120 kg N: P_2O_5 ha^{-1} through fertigation under open field condition is profitable during summer season in the Eastern Dry Zone of Karnataka.

Keywords: *Cherry tomato, Fertigation, Growing conditions, Yield, Growth.*

INTRODUCTION

Cherry tomato [*Solanum lycopersicum* L. var. *cerasiforme* (Dunnal) A. Gray] is a botanical form of cultivated tomato with small size fruits, bright red colour and excellent taste. It is a multipurpose type of tomatoes which is consumed more as a fruit rather than as a vegetable and appropriate for making processed products like sauce, soup, ketchup, paste and powder.

Cite this article: Farooqi, A., Narase Gowda, N. C., & Niazy, H. (2021). Response of cherry tomato [*Solanum lycopersicum* L. var. *cerasiforme* (Dunnal) A. Gray] to varied levels of nitrogen and phosphorus fertigation under open field and polyhouse conditions, *Ind. J. Pure App. Biosci.* *9*(3), 1-6. doi: http://dx.doi.org/10.18782/2582-2845.8671

Cherry tomato, besides being tasty, is useful for maintaining good health due to its higher nutritional value. It is a great source of vitamin C (13mg 100 g^{-1}), dietary fibre (2.0 g), vitamin A (25 %), vitamin K and also a good source of vitamin E (Alpha Tocopherol), thiamine, niacin, vitamin B6, folate, phosphorus, copper, potassium and manganese. They are low in sodium and very low in total fat (0.3 g), saturated fat (0.1 g) and cholesterol (Renuka et al., 2015).

It is a well-established fact that all plants need nutrients to grow. Among them, the "Big 3" or NPK are vitally important and have profound effect on crop productivity and quality. The basis of application of these nutrients is consisted of using the right dose, at the right time and place which should be taken into consideration. Luckily, fertigation is one of the most effective ways to effectively manage water and nutrient application.

In most of the Asian countries such Afghanistan and India, farmers generally follow the traditional methods of irrigation and fertilizer application which affect negatively on yield and lead to excessive wastage of water and nutrients, besides contributing to soil and water pollution. Fertigation guarantees that the plant is getting precise dose of nutrients directly into the zone of maximum root activity as per the crop need in most efficient manner. The concentration of NPK of the nutrient solutions and the application time and intervals are of vital importance for adequate uptake and optimal growth of tomato (Ughade et al., 2016). Shivashankar et al. (1998) suggested that, fertigation provides a variety of benefits to the users such as increased crop productivity with quality, resource use efficiency, environmental safety, flexibility in field operations, effective weed management and successful crop cultivation on fields with undulating topography. Tu et al. (2004) stated that, drip irrigation and drip fertigation significantly increase tomato yield and reduce the percentage of tomato fruits with blossom-end rot. Shedeed et al. (2009) reported that, frequent supplementation of nutrients with irrigation water increased the the availability of N, P and K in the root zone which in turn influenced the yield and quality of tomato. Similarly, many other investigators reported increased growth and yield of vegetable crops under fertigation (Bresler, 1977) and (Malik et al., 1994).

On the other hand, growing condition is another major factor that has a larger impact on growth, yield and quality of vegetable crops. Higher temperatures in the greenhouse affect several physiological and biochemical processes of tomato crop associated with yield reduction (Dinar & Rudich, 1985). Relative humidity is higher inside the greenhouse than in the open field condition that results in increased infestation of vegetable crops (Nimje & Shyam, 1993). Harmanto et al. (2005) siad that, the microclimatic conditions inside the greenhouse in tropical climate may be temporarily less favorable as compared to unprotected cultivation. Heat stress is one of the most important constraints for tomato crop which adversely affects both vegetative and reproductive processes resulting in reduced yield and fruit quality (Abdul-Baki, 1991). Keeping these points in view, the present experiment was conducted to study the combined effect of different levels of nitrogen and phosphorus fertigation under open field and polyhouse conditions on growth, yield and quality of cherry tomato production.

MATERIALS AND METHODS

An open field and polyhouse experiment was conducted at the Horticulture Research Station, Department of Horticulture, University of Agricultural Sciences, Bangalore, India during the summer season of 2017 (January to June). The station is located at 12º 59" North latitude and 77º 34" East longitude with altitude of 930 meters above mean sea level. The area represents Eastern Dry Zone of Karnataka (Zone-V) and characterized by sub-tropical climate. Actual average rainfall of the center during the period of study, between January-2017 to June-2017 was 53.9 mm, the major portion of which was received during May (246.6 mm) and June (65.4 mm). The mean maximum air temperature ranged between 27.3°C to 35.1°C and mean minimum air temperature ranged between 9.5°C to 21.9°C. The highest average temperature of 35.1°C was recorded during April followed by 33.0 °C during March and 32.7°C in May, 2017. Mean monthly relative humidity varied from 82.0 per cent in March to 88.9 per cent in January. The soil of the experimental site was red sandy loam with pH 7.13 and EC 0.3 dS/m under open field condition and pH 6.76 and EC 0.4 dS m^{-1} under polyhouse. Cabbage crop was grown as previous crop on the experimental polyhouse and under open field condition, there was no crop taken before this experiment for several years.

There were 12 treatment combinations comprising of two growing conditions (open field and polyhouse), three levels of nitrogen (120, 150 and 180 kg N ha^{-1}) and two levels of phosphorus (100 and 120 kg P_2O_5 ha^{-1}) supplied trough fertigation with recommended potassium (150 kg h^{-1}) as constant which were laid out in Factorial Randomized Complete Block Design with three replications. The details of treatment combinations of all three factors *viz.*, two growing conditions (C_1 and C_2), three levels of nitrogen (N_1, N_2 and N_3) and two levels of phosphorus (P_1 and P_2) were as follows:

$C_1N_1P_1$ (Polyhouse +120:100 kg N:P_2O_5 ha^{-1})
$C_1N_1P_2$ (Polyhouse + 120:120 kg N:P_2O_5 ha^{-1})
$C_1N_2P_1$ (Polyhouse + 150:100 kg N:P_2O_5 ha^{-1})
$C_1N_2P_2$ (Polyhouse + 150:120 kg N:P_2O_5 ha^{-1})
$C_1N_3P_1$ (Polyhouse +180:100 kg N:P_2O_5 ha^{-1})
$C_1N_3P_2$ (Polyhouse + 180:120 kg N:P_2O_5 ha^{-1})
$C_2N_1P_1$ (Open field +120:100 kg N:P_2O_5 ha^{-1})
$C_2N_1P_2$ (Open field + 120:120 kg N:P_2O_5 ha^{-1})
$C_2N_2P_1$ (Open field + 150:100 kg N:P_2O_5 ha^{-1})
$C_2N_2P_2$ (Open field + 150:120 kg N:P_2O_5 ha^{-1})
$C_2N_3P_1$ (Open field + 180:100 kg N:P_2O_5 ha^{-1})
$C_2N_3P_2$ (Open field +180:120 kg N:P_2O_5 ha^{-1})

Twenty per cent N, P and K of each treatment was applied before transplanting as basal fertilizer dose and remaining dose of 80 per cent NPK was applied through fertigation using water soluble fertilizers from 21^{th} day after transplanting up to 129 days prior to final harvest. A Total of 37 fertigations were done at an interval of once in three days. At initial stage of the growth, fertigation was given in lesser doses. Further, the quantity of fertilizers per fertigation increased as the growth of the plants increased at mid and late stages of plant life cycle.

The seeds of cherry tomato cv. Moscatel RZ F1 (74-104) were sown in plastic pro trays by using cocopeat under naturally ventilated polyhouse. After one month, healthy tomato seedlings were transplanted in the open field and polyhouse and planted in a single row per bed, as the row to row and plant to plant spacing was kept at 1.20 m and 0.45 m, respectively. Standard plant protection measures were taken up against pests and diseases. The beds were irrigated through drip irrigation system according to the weather, soil and growth stage of the crop and kept free of weeds by plastic mulch and manual weeding at regular intervals as when weeds appeared.

Five plants out of 12 were selected at random and tagged in each replication for recording various biometric observations to assess the effect of treatments on growth, yield and quality of cherry tomato. The data pertaining to the present investigation was subjected to statistical analysis using 2x3x2 Factorial Randomized Complete Block Design. The significant treatment effect was judged with the help of F-test at p= 0.05 and to judge the significant difference between treatments, the critical difference was worked out ((Panse & Sukhatme, 1984).

RESULTS AND DISCUSSION

1. Vigour and growth parameters

A perusal of data (Table-1) revealed that plant height (384.39 cm), fresh weight per plant (3.00 kg), total leaf area per plant (6293 cm^2) and nitrogen balance index (48.56) were significantly higher under polyhouse condition when supplied with 180: 120 kg N: P_2O_5 ha^{-1} ($C_1N_3P_2$) compared to open field with varied levels of nitrogen and phosphorus fertigation. Increased growth parameters under treatment combination of $C_1N_3P_2$ could be due to favorable climatic conditions under protected structure with higher nitrogen and phosphorus supply which has increased the rate of metabolic activity leading to an increase in various plant metabolites responsible for cell division. The results are in conformity with the findings of Singh et al. (2005), Tiwari et al. (2012) and Ughade et al. (2016). However, nitrogen and phosphorus levels under both growing conditions had no significant effect on flavanol and total chlorophyll contents.

Table 1: Effect of different growing conditions, nitrogen and phosphorus fertigation levels on growth and biochemical parameters of cherry tomato

Treatment combinations	Plant height (cm)	Fresh weight per plant (kg)	Total leaf area per plant (cm^2)	Total chlorophyll ($\mu g/cm^2$)	Flavanol content ($\mu g/cm^2$)	Nitrogen Balance Index (NBI)
$C_1N_1P_1$ (Polyhouse +120:100 kg $N:P_2O_5$ ha^{-1})	337.42	2.09	4994	28.13	0.586	45.65
$C_1N_1P_2$ (Polyhouse + 120:120 kg $N:P_2O_5$ ha^{-1})	342.66	2.09	4313	24.61	0.543	45.07
$C_1N_2P_1$ (Polyhouse + 150:100 kg $N:P_2O_5$ ha^{-1})	341.38	2.29	4888	25.45	0.563	44.08
$C_1N_2P_2$ (Polyhouse + 150:120 kg $N:P_2O_5$ ha^{-1})	348.38	1.82	5129	26.18	0.576	43.92
$C_1N_3P_1$ (Polyhouse +180:100 kg $N:P_2O_5$ ha^{-1})	361.34	2.14	5849	25.91	0.495	41.13
$C_1N_3P_2$ (Polyhouse + 180:120 kg $N:P_2O_5$ ha^{-1})	384.39	3.00	6293	26.41	0.590	48.56
$C_2N_1P_1$ (Open field +120:100 kg $N:P_2O_5$ ha^{-1})	274.50	2.02	4769	29.64	0.723	38.03
$C_2N_1P_2$ (Open field + 120:120 kg $N:P_2O_5$ ha^{-1})	264.18	1.78	4795	27.46	0.826	34.25
$C_2N_2P_1$ (Open field + 150:100 kg $N:P_2O_5$ ha^{-1})	262.24	2.01	4506	27.03	0.836	32.50
$C_2N_2P_2$ (Open field + 150:120 kg $N:P_2O_5$ ha^{-1})	284.38	2.69	5708	29.37	0.886	34.63
$C_2N_3P_1$ (Open field + 180:100 kg $N:P_2O_5$ ha^{-1})	276.97	1.69	5964	28.07	0.780	35.56
$C_2N_3P_2$ (Open field +180:120 kg $N:P_2O_5$ ha^{-1})	292.35	2.32	5378	25.28	0.930	27.73
F-test (p=0.05)	*	*	*	NS	NS	*
S.Em.±	6.15	0.34	452.67	28.13	0.090	3.97
C.D. (p=0.05)	10.41	0.58	766.44	24.61	-	6.72

*= Significant NS= Non –significant

Table 2: Effect of different growing conditions, nitrogen and phosphorus fertigation levels on reproductive, yield and quality parameters and cost benefits of cherry tomato

Treatment combinations	Day taken to first flowering (Days)	Fruit set (%)	Mean fruit weight (g)	Yield per hectare (t)	TSS (°B)	Shelf life (Days)	Cost: benefit ratio
$C_1N_1P_1$ (Polyhouse +120:100 kg $N:P_2O_5$ ha^{-1})	21.33	51.37	13.97	42.73	4.90	13.33	0.81
$C_1N_1P_2$ (Polyhouse + 120:120 kg $N:P_2O_5$ ha^{-1})	22.00	52.17	12.56	32.57	4.66	14.00	0.38
$C_1N_2P_1$ (Polyhouse + 150:100 kg $N:P_2O_5$ ha^{-1})	21.66	51.12	13.79	34.59	4.83	13.66	0.44
$C_1N_2P_2$ (Polyhouse + 150:120 kg $N:P_2O_5$ ha^{-1})	21.00	51.70	15.13	37.11	4.63	14.66	0.54
$C_1N_3P_1$ (Polyhouse +180:100 kg $N:P_2O_5$ ha^{-1})	21.66	50.88	15.14	35.55	5.10	15.33	0.46
$C_1N_3P_2$ (Polyhouse + 180:120 kg $N:P_2O_5$ ha^{-1})	22.00	52.73	15.84	37.91	6.30	15.66	0.55
$C_2N_1P_1$ (Open field +120:100 kg $N:P_2O_5$ ha^{-1})	21.33	52.95	11.69	61.16	4.33	13.33	3.71
$C_2N_1P_2$ (Open field + 120:120 kg $N:P_2O_5$ ha^{-1})	21.66	49.91	13.63	58.36	4.33	11.33	3.48
$C_2N_2P_1$ (Open field + 150:100 kg $N:P_2O_5$ ha^{-1})	21.33	53.69	14.53	62.84	4.76	12.66	3.68
$C_2N_2P_2$ (Open field + 150:120 kg $N:P_2O_5$ ha^{-1})	22.00	49.49	15.48	78.16	4.93	15.66	4.81
$C_2N_3P_1$ (Open field + 180:100 kg $N:P_2O_5$ ha^{-1})	22.00	51.06	15.98	66.54	4.96	15.33	3.81
$C_2N_3P_2$ (Open field +180:120 kg $N:P_2O_5$ ha^{-1})	23.00	51.47	15.76	55.87	5.13	15.33	3.03
F-test (p=0.05)	*	NS	*	*	*	*	-
S.Em.±	0.39	1.84	0.92	5.21	0.33	0.93	-
C.D. (p=0.05)	0.66	-	1.56	8.82	0.56	1.57	-

*= Significant NS= Non –significant

2. Reproductive parameters

Significantly maximum number of days to first flowering (23.00 days) was recorded under open field condition with 180:120 kg N: P_2O_5 ha^{-1}. Delayed days to first flowering under open field with higher levels of nitrogen and phosphorus fertigation might be due to the influence of lower temperature at the early stages of the growth and higher nutrition, particularly, nitrogen at higher doses leads to excessive vegetative growth and extend the vegetative phase. These results are in line with the findings of Tiwari et al. (2012) who stated that temperature affects flower initiation and Sing et al. (2005) who said that higher levels of NPK lead to excessive vegetative growth and delay maturity. Fruit set did not differ significantly due to different growing conditions, nitrogen and phosphorus fertigation levels.

3. Yield and Yield attributes

Mean fruit weight (15.98 g) was significantly higher under open field condition with 180:100 kg $N:P_2O_5$ ha^{-1} compared to other treatments. The increase in fruit weight with the increase in fertigation level might be due to more availability of nutrients to plants and effective utilization of nutrients during critical stages of crop growth which ultimately resulted in maximum fruit weight.

Significantly highest yield per hectare (78.16 t) was recorded under open field condition when supplied with 150:120 kg N: P_2O_5 ha^{-1} followed by $C_2N_3P_1$ (66.54 t ha^{-1}). However, lower yield (32.57 t ha^{-1}) was observed under polyhouse condition with 120:120 kg N: P_2O_5 ha^{-1}). Increased yield under open field with optimum levels of nitrogen and phosphorus fertigation might be due to optimum combination of nitrogen and phosphorus resulting in a favourable source to sink ratio to produce higher yield. Reduced yield parameters under low cost polyhouse condition might be due to the adverse effect of extreme high temperature during reproductive stage in summer months that causes dryness of stigma and flower abortion. These results are in close conformity with those of Harmanto and Rabel (2005) and Dinar and Rudich (1985) who observed that, higher temperatures in the greenhouse, affect several physiological and biochemical processes of tomato crop associated with yield reduction.

4. Quality parameters and Economic analysis

It is observed in the present study that TSS content (6.30 ºB) and shelf life (15.66 days) were significantly higher for the crop grown under polyhouse condition when supplied with 180: 120 kg N: P_2O_5 ha^{-1}. This might be due to the fact that, higher fertility levels increase uptake and utilize more nutrients which increases total soluble solid content of fruits. Thus, increase in quality parameters under polyhouse condition with higher nitrogen and phosphorus fertigation levels can be attributed to increased uptake of nitrogen, phosphorus and potassium which in turn enhanced the photosynthetic activities in plant system for better accumulation of CHO in plant. The results are in close conformity with the findings of Mahajan and Sing (2006). Calculation of benefit and cost of cultivation revealed that, highest B: C ratio (4.81) was recorded in T_{10}- $C_2N_2P_2$ (open field with 150: 120 kg N: P_2O_5 ha^{-1}). The higher benefit: cost ratio registered by the cherry tomato under open field with optimum levels of nitrogen and phosphorus fertigation are attributed to higher fruit yield recorded by this crop in the present study.

CONCLUSION

This study has shown that growing conditions, nitrogen and phosphorus fertigation had profound impact on growth and yield of cherry tomato. Growth parameters were superior under polyhouse condition with higher levels of fertigation where application of 150:120 kg N: P_2O_5 ha^{-1} through fertigation under open field condition produced the higher yield of cherry tomato besides higher cost benefit ratio and proved to be a profitable treatment for cherry tomato during summer season in the Eastern Dry Zone of Karnataka.

Acknowledgment

The authors would like to thank The Indian Council for Cultural Relations (ICCR) for granting of scholarship and financial support and Department of Horticulture, UAS, GKVK, Bangalore for providing the necessary materials and technical support.

REFERENCES

Abdul-Baki, A. A. (1991). Tolerance of tomato cultivars and selected germplasm to heat stress. *J. Amer. Soc. Hort. Sci*. *116*(6), 1113-1116.

Bresler, E. (1977). Trickle-drip irrigation: Principles and applications to soil-water management. *Adv. Agron*. *29,* 343−393.

Dinar, M., & Rudich, J. (1985). Effect of heat stress on assimilates partition in tomato. *Ann. Bot*. *56*(2), 239-248.UGHADE, S. R., TUMBARE, A. D., & SURVE, U. S. (2016). Response of tomato to different fertigation levels and schedules under polyhouse. *International J. Agric. Sci*. *12*(1), 76-80.

Harmanto, S. V. M., & Babel, M. S. (2005). Water requirement of drip irrigated tomatoes grown in greenhouse in tropical environment. *Agric. Water Manag*. *71*, 225-242.

Malik, R. S., Kumar, K., & Bhandari, A. R. (1994). Effect of urea ap-plication through drip irrigation system on nitrate distribution in loamy sand soils and pea yield. *I. Indian Soc.Soil Sci. 42*, 6-10.

Mahajan, G., & Singh, K. G. (2006). Response of Greenhouse tomato to irrigation and fertigation. *Agric. Water. Manag. 84*, 202-206.Tiwari, S. P., Hemant, K. P., Sharma, D., Agrawal, N., Agrawal, R., & Dubey, P. (2012). Studies of different fertigation levels on morphophysiological characters and yield of tomato under greenhouse condition. *Asian J. Hort. 7*(2), 613-614.

Nimje, P. M., & Shyam, M. (1993). Effect of plastic greenhouse on plant micro climate and vegetable crop production. *Fng. System, 9*, 13-19.

Panse, V. G., & Sukhatme, P. V. (1984). Statistical method for agriculture workers. *Indian council of Agriculture Research*, New Delhi.

Renuka, D. M., Sing, T. H., Geetha, S. V., & Sheela, M. (2015). Combing ability analysis of growth, yield and quality traits in cherry tomato (*Solanum lycopersicum var. cersiforme*). *Int. J. Adv. Res. 3*(7), 319-325.

Shivashankar, K., Khan, M. M., & Farooqui, F. A. (1998). Fertigation studies with water soluble NPK fertilizers in crop production. UAS, Bangalore, pp. 32.

Singh, A. K., Gupta, M. J., Srivastava, R., & Behera, T. K. (2005). Effect of NPK levels on growth and yield of tomato hybrids under multi-span polyhouse. *Indian J. Hort. 62*(1), 91-93.

Shedeed, S. I., Zaghloul, S. M., & Yassen, A. A. (2009). Effect of method and rate of fertilizer application under drip irrigation on yield and nutrient uptake by tomato. *Ozen. J. Appld. Sci. 2*(2), 139-147.

Tu, J. C., Liptay, A., Tan, C. S., Drury, C. F., & Reynolds, D. (2004). Effect of drip irrigation and drip fertigation on yield of processing tomato in South Western Ontario, *Acta Hort. 635*, 195-200.