American-Eurasian J. Agric. & Environ. Sci., 15 (12): 2442-2445, 2015
ISSN 1818-6769

DOI: 10.5829/idosi.aejaes.2015.15.12.12654

Effect of Different Levels of Nitrogen Sources and Spacing on Growth and Yield of Tomato (*Lycopersicon esculentum* L.) VAR. *Thilina* in the Eastern Region of Sri Lanka

[1]*S. Sutharsan and* [2]*M. Rajendran*

[1]Department of Crop Science, Faculty of Agriculture, Eastern University, Sri Lanka, Sri Lanka
[2]Department of Agricultural Engineering, Faculty of Agriculture, Eastern University, Sri Lanka, Sri Lanka

Abstract: The study aimed to investigate the effect of different levels of organic nitrogen (ON) and inorganic nitrogen (IN) sources and plant spacing on growth and yield of tomato (var. *Thilina*). Plants were grown at three different spacing (S_1- 80 × 35cm, S_2- 80 × 50cm and S_3- 80 × 80cm) and three different levels of nitrogen sources (N_1- 75% of IN + 25% of ON, N_2- 50% of IN +50% of ON and N_3- 25% of IN +75% of ON). The results showed significant variations ($p<0.05$) on plant height, leaf area and plant biomass at harvesting time and fruit yield of tomato among treatments. Treatment N_1S_3 produced highest leaf area (1450.78cm^2/plant). However, N_1S_1 produced highest plant biomass (2648.70kg.ha^{-1}) and fruit yield (27.93t.ha^{-1}). This study suggested that combination of 75% of IN and 25% of ON and plant spacing of 80 × 35cm is most favoured option to increase the productivity of tomato in the Eastern region of Sri Lanka.

Key words: Biomass · Nitrogen sources · Plant spacing · Sandy regosol · Yield

INTRODUCTION

Tomato *(Lycopersicon esculetum* L.) is rich in vitamins and minerals and has several medicinal values as well. It is a popular vegetable in Sri Lanka. However, fruit yield of tomato compared to other countries is very low. Among the factors which are attributed for low fruit yield of tomato, fertilizer application and plant spacing are important. Two management practices which greatly influence tomato fruit yield are spacing and fertilizer application [1]. Among the all plant nutrients, nitrogen is a principal nutrient influences yield of tomato [2, 3].

In modern agriculture, nitrogen is commonly provided through inorganic fertilizers such as urea, ammonium sulphate etc. However, these are considered as major sources of environmental pollution. Increased application of mineral fertilizers in agriculture pollutes water and soil in many ways. Furthermore, continuous application of synthetic fertilizers degrades land productivity. Hence, usage of such mineral fertilizers in agriculture should be reduced in possible ways without any compromise on crop productivity. Use of organic fertilizers in crop production is the best option to mitigate these problems. However, application of organic manures alone does not produce economic crop yield. Therefore, selection of appropriate combinations of such inorganic and organic fertilizers is important to obtain economic crop yield. Further, plant density is another important factor which influences yield of many crops. Increasing plant density is one of the best options to increase fruit yield of tomato. It was reported that increasing economic yield of most crops is through cropping at high planting density [4]. However, plant density above the optimum level may affect fruit yield of tomato. This study was therefore conducted to determine the optimum combination of organic and inorganic nitrogen sources and optimum plant spacing to increase yield of tomato in sustainable way in the eastern region of Sri Lanka.

MATERIALS AND METHODS

The experiment was carried out from November 2011 to March 2012 at crop farm, Eastern University Sri Lanka, Batticaloa. The soil was sandy regosol. Tomato variety '*Thilina*' was used for this experiment. A 3×3 factorial arrangement fitted into randomized complete block design (RCBD) with three replications comprising three different levels of nitrogen sources

Corresponding Author: S. Sutharsan, Department of Crop Science, Faculty of Agriculture, Eastern University, Sri Lanka.

(N_1-75% of IN + 25% of ON, N_2-50% of IN + 50% of ON and N_3- 25% of IN 75% of ON) and three different levels of plant spacing (S_1- 80× 35cm, S_2- 80 × 50 cm and S_3- 80 × 80cm) was used. Each plot size was 4m × 4m. Well developed, vigorous and uniform seedlings of tomato from the nursery were transplanted in field at three different plant spacing. Three different combinations of inorganic and organic nitrogen fertilizers were applied as mentioned above. Urea was used as inorganic source of nitrogen while compost for organic nitrogen. Required amount of compost for each treatment was applied as basal dressing. The other major nutrients such as phosphorous and potassium were also supplied according to department recommendation to all plots through inorganic fertilizers. Plant height (cm), leaf area (cm^2), biomass ($kgha^{-1}$) at harvesting stage and fresh fruit yield ($t\ ha^{-1}$) were measured and analyzed by analysis of variance (ANOVA) and means were compared by Turkey's test at 5% probability level.

RESULTS AND DISCUSSION

Effect of Spacing on Plant Height: There were significant variations ($p<0.05$) on plant height among different treatments at harvesting stage (Fig.1). Highest plant height of 98 cm was recorded in narrow spacing (80× 35cm), while the lowest plant height of 92 cm was obtained in wider spacing (80× 80cm) irrespective of nitrogen sources. Change in plant density has shining influences on plant height, where it increases by a decreasing space between plants [5]. It is also evidence that plant height of tomato increases at closer spacing than at wider spacing [6, 7]. Higher number plants per unit area coupled with inter- plant competition could be attributed for increased plant height.

Effect of Nitrogen Source on Plant Height: Plant height was significantly ($p<0.05$) affected by source of nitrogen (Fig. 2). Plants received 75% of IN and 25% of ON produced highest plant height (102 cm) followed by plants received 50% of IN and 50% of ON (92 cm) as compared to plants received lowest ratio of IN. Among all the nutrients required for plant growth and development, nitrogen (N) is often limiting factor. Inorganic nitrogen sources used in crop production increases available nitrogen to the plants. In this study, application of inorganic nitrogen in higher proportion increased plant height significantly than other treatments which received lower levels of inorganic nitrogen.

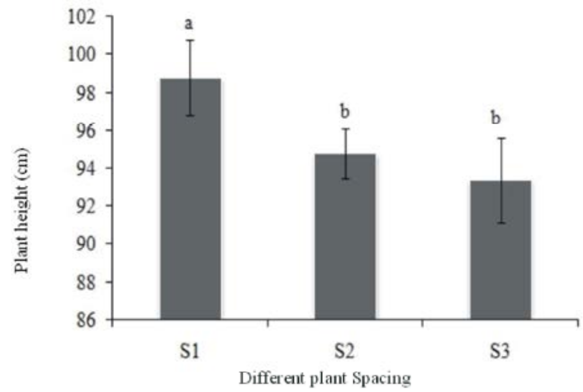

Fig. 1: Effect of different spacing on plant height at harvesting stage
Values are means ±SE of 3 replicates

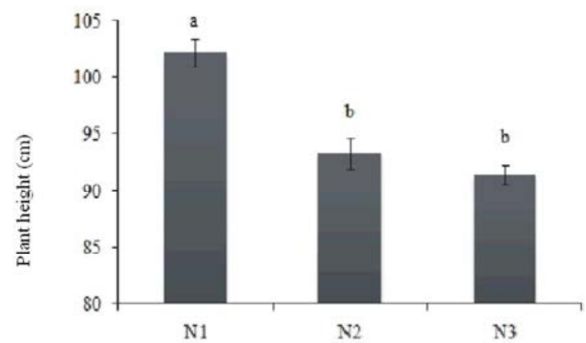

Fig. 2: Effect of different levels of nitrogen sources on plant height at harvesting stage
Values are means ± SE of 3 replicates

When organic fertilizer is added to a substrate, the organic N source in organic fertilizer needs to go through a mineralization process to convert organic N compounds into ammonium and a subsequent process that oxidizes the ammonium to nitrate [8]. Plant receiving nitrate as N source had better plant growth and higher biomass than those receiving ammonium as N source [9].

Leaf Area: The results showed that changes in nitrogen source and plant spacing significantly ($p<0.05$) affect leaf area of tomato. The interaction effect of nitrogen source and spacing was also significant (Table 1). The highest leaf area (1450.78 cm^2) was produced by the plants belong to N_1S_3 followed by N_2S_3 (1361.11 cm^2), while lowest leaf area (1042.33 cm^2) was produced by the plants belong to N_3S_1. Increased level of inorganic N source with wider spacing had increased leaf area of tomato significantly. It may be due to high availability of nitrogen and reduced inter- plant competition. It is found that leaf area per plant

Table 1: Effect of different levels of nitrogen sources and spacing on leaf area of tomato at harvesting stage

Source and levels of nitrogen	Plant spacing	Leaf area (cm^2)
	S1	1200.56[b]
N1	S2	1151.22[b]
	S3	1450.78[a]
	S1	1062.78[b]
N2	S2	1295.22[a]
	S3	1361.11[a]
	S1	1042.33[a]
N3	S2	1074.22[a]
	S3	1069.89[a]

Means with different letter within the spacing are significant at $p < 0.05$

Table 2: Effect of different levels of nitrogen sources and spacing on plant biomass at harvesting stage and fruit yield

Source and levels of nitrogen	Plant spacing	Plant biomass (kg/ha)	Yield (t/ha)
N1	S1	2648.70[a]	27.93[a]
	S2	1921.28[b]	19.68[b]
	S3	1627.14[c]	17.75[b]
N2	S1	2188.29[a]	20.22[a]
	S2	1914.83[b]	18.91[ab]
	S3	1492.83[c]	16.67[b]
N3	S1	2055.83[a]	16.15[a]
	S2	1398.31[b]	11.43[b]
	S3	1064.44[c]	10.30[b]

Means with different letter within the spacing are significant at $p<0.05$

increases with increasing N level [10]. Widely spaced plants may produce higher number of leaves per plant as they have more environmental resources for growth than closely spaced plants [11].

Plant Biomass and Fruit Yield: Different levels of nitrogen sources (N) and spacing (S) had significant effect ($p<0.05$) on plant biomass and fruit yield of tomato. N×S interaction effect was also significant (Table 2). Plants belong to treatment N_1S_1 produced significantly highest plant biomass (2648.70 kg ha^{-1}) and fruit yield (27.93 t. ha^{-1}) than other treatments. Lower plant density per unit area produces more vigorous plants than at higher plant densities. However, it could not balance for a reduced number of plants per unit area. High level of inorganic N source had increased both plant biomass and fruit yield significantly. Higher availability of nitrogen through inorganic fertilizers could be attributed for higher biomass and fruit yield of tomato. The increments in the nitrogen rate of the fertilizers increase the yield and fruit number [12]. It also influences on fruit weight of tomato [13]. Total yield and plant biomass were increased with reduced plant spacing. It is found that plant spacing has great influence on fruit yield [14, 15]. Highest fruit yield (kg ha^{-1}) of sweet pepper was obtained from plants grown at high density [16, 17]. Increase in plant number per unit area could be attributed to the production of extra yield per unit area.

From this study, it could be concluded that combination of 75% of inorganic and 25% of organic levels of nitrogen and plant spacing of 80 × 35cm is the best option to increase the productivity of tomato (var.*Thilina*) in the Eastern region of Sri Lanka.

REFERENCES

1. Abdel-Mawgoud, N.H.M., El-Greadly, Y.I. Helmy and S.M. Singer, 2007. Responses of tomato plants to different rates of humic-based fertilizer and NPK fertilization. J. Appl. Sci. Res., 3(2): 169-174.
2. Locascio, S.J., G.J. Hochmuth, F.M. Rhoads, S.M. Olsen, A.G. Smajstrla and E.A. Hanlon, 1997. Nitrogen and potassium application scheduling effects on drip-irrigated tomato yield and leaf tissue analysis. HortScience., 32(2): 230-235.
3. Clark,M.S., W.R. Horwath, C. Shennan, K.M. Scow, W.T. Lantni and H. Ferris, 1999. Nitrogen, weeds and water as yield-limiting factors in conventional, low-input and organic tomato systems. J. Agric. Ecosystems and Environ.,73(3): 257-270.
4. Bodunde, J.G., I.D. Erinle and P.G. Eruotor, 1996. Selecting tomato genotypes for heat tolerance using Fasoulas' line method. Proceeding of 14th HORTON conference, Ago-Iwoye, 1-4 April, 1996, pp: 24-34.
5. Dahmardeh, M., M. Ramroodi and J. Valizadeh, 2010. Effect of plant density and cultivars on growth, yield and yield components of faba bean (*Vicia faba* L.). African J. Biotech., 9(50): 8643-8647.
6. Mbinga, E.W., 1983. Pruning and Spacing Effect on Tomato var. Seeda Nam Khem. ARC Training Report. pp: 1-4.
7. Gupta, A. and V. Shukla, 1977. Response of tomato to plant spacing, nitrogen, phosphorus and potassium fertilizer. Ind. J. Hor., 34(3): 270-276.
8. Gaskell, M. and R. Smith, 2007. Nitrogen sources for organic vegetable crops. Horttechnology, 17: 431-441.
9. Gweyi-Onyango, J.P., G. Neumann and V. Römheld, 2009. Effect of different forms of nitrogen on relative growth rate and growth components of tomato (*Lycopersicon esculentum* L.). African J. Hort. Sci., 2: 43-55.

10. AIsadon, A.A. and S.O. Khalil, 1993. Effect of Nitrogen Level on Two Tomato Cultivars under Plastic House Conditions. J. King Saud Univ., 5(1): 69-77.
11. Miko, S. and A.A. Manga, 2008. Effect of intra- spacing and nitrogen rates on growth and yield of sorghum (*Sorghum bicolor* L.) Var. ICSV 400. J. Proc. Anal. Tech., (PAT)., 4(2): 66-73.
12. Law, O. and E. Egharevba, 2009. Effects of planting density and NPK fertilizer application on yield and yield components of tomato (*Lycopersicum esculentum* Mill) in forest Location. World J. Agric. Sci., 5(2): 152-158.
13. Sharma, K.C., A.K. Singh and S.K. Sharma, 1999. Studies on nitrogen and phosphorus requirement of tomato hybrids. Annals of Agric. Res., 20(4): 339-402.
14. Lemma, D., Z. Yayeh and E. Herath, 1992. Agronomic Studies in Tomato and Capsicum. *In*: Herath and Lemma (eds.). Horticulture Research and Development in Ethiopia: Proceedings of the Second National Horticultural Workshops of Ethiopia. 1-3 December. Addis Ababa, Ethiopia, pp: 53-163.
15. Mehla, C.P., V.K. Srivastava, S. Jage, R. Mangat, J. Singh and M. Ram, 2000. Response of tomato varieties to N and P fertilization and spacing. Ind. J. Agric. Res., 34(3): 182-184.
16. Nasto, T.H., A. Balliu and N. Zeka, 2009. The influence of planting density on growth characteristics and fruit yield of peppers (*Capsicum annuum* L.). Acta Hort., 830: 906-912.
17. Khasmakhi-Sabet, A., S. Sedaghathoor, J. Mohammady and A. Olfati, 2009. Effect of plant density on Bell pepper yield and quality. Int. J. Veg. Sci., 15: 264-271.