Available online at www.ijrp.org

International Journal of Research Publications

Effects of Different Levels of Nitrogen Sources and Spacing on Growth and Yield of Tomato (Lycopersicon esculentum Mill) var. Thilina

S. Sutharsan[a] and M. Rajendran[b]*

[a]Department of Crop Science, Faculty of Agriculture, Eastern University, Sri Lanka
[b]Department of Agricultural Engineering,, Faculty of Agriculture, Eastern University, Sri Lanka

Abstract

An appropriate combination of inorganic and organic nitrogen sources and plant spacing is vital to increase the yield of tomato with minimum environmental hazards. We therefore carried out this experiment at the Crop Farm, Faculty of Agriculture, Eastern University, Sri Lanka to investigate the effects of different levels of organic nitrogen (ON) and inorganic nitrogen (IN) sources and plant spacing on growth and yield of tomato (Lycopersicon esculentum Mill.). Plants were grown at three different spacing (S1- 80 cm × 35 cm, S2- 80 cm × 50 cm and S3- 80 cm × 80 cm) and at three different levels of nitrogen sources (N1- 75% of IN + 25% of ON, N2- 50% of IN +50% of ON and N3- 25% of IN +75% of ON). The results showed significant variations on plant height, leaf area and plant biomass at harvesting time and fruit yield of tomato among treatments. Treatment N1S3 produced highest leaf area (1450.78 cm^2 /plant). However, N1S1 produced highest plant biomass (2648.70 $kg.ha^{-1}$) and fruit yield (27.93 $Mt.ha^{-1}$). This study therefore suggests that combination of 75% of IN and 25% of ON and plant spacing of 80 cm × 35 cm is most favoured option to increase the productivity of tomato in Batticaloa region.

* Corresponding author. Tel.: +94 773457210.
E-mail address: rajanv.puram@yahoo.com.

Keywords: Biomass, Nitrogen sources, Plant spacing, Sandy regosol, Tomato yield

---

1. Introduction

Tomato (Lycopersicon esculentum Mill.) is a popular vegetable in Sri Lanka. It is rich in vitamins and minerals and has several medicinal values as well. Tomato fruit yield compared to other countries is very low in Sri Lanka. The average yield of tomato and extent of cultivation vary from place to place and season to season. Average fruit yield of tomato in the eastern region of Sri Lanka is nearly 50% of the national average yield. For instance, national average yield of tomato was 12.1 Mt/ha whilst it was 6.4 Mt/ha in Batticaloa (Department of Census and Statistics, 2015). It has great impact on the livelihoods of farming communities. Among the factors which are attributed for low fruit yield of tomato, fertilizer application and plant spacing are important. This was in response to Abdel-Mawgoud et al. (2007) who reported that two management practices which greatly influence tomato fruit yield are spacing and fertilizer application. Nitrogen is a principal nutrient influences yield of tomato (Locascio et al., 1997; Clark et al. 1999).

Nitrogen can be supplied through organic and inorganic fertilizers. Both types of fertilizers have their own merits and demerits. Inorganic fertilizers ensure quick availability of nutrients to crops. However, they have limited residual effect of the applied nutrients (Okigbo, 2000). Further, reckless use of such inorganic fertilizers can create nutrient imbalance that limits the uptake of other essential nutrients and cause acidity leading to low crop yield (Usman et al., 2015). Addition of organic amendments is necessary to manage the current trend of soil physical, chemical and biological degradation (Chukwu et al., 2012). However, nitrogen availability is the most important in organic cultivation of tomato as it limits yield (Clark et al., 1999). Hence, application of organic fertilizers alone would not produce economic crop yield. Further, they are required in large quantities which may not be readily available to small scale farmers (Okigbo, 2000; Adekiya et al., 2012). The combined use of organic and inorganic fertilizers will be a viable option to increase the crop yield while improving soil characteristics (Cezar, 2004; Chukwu et al., 2012). However, selection of appropriate combinations of such inorganic and organic fertilizers is important to obtain economic crop yield.

Several studies reported that plant density is an important factor which influences yield of tomato (e.g. Mehla et al., 2000; Hooda et al., 2001; Warner et al., 2002). Economic yield of most crops can be increased through cropping at high planting density (Bodunde et al., 1996). On the other hand, intra-plant competition becomes more important with increasing plant density. Wider spacing minimizes competition for nutrients, water and sunlight with increased air circulation. Some studies reported higher fruit yield at wider spacing than close spacing (e.g. Ara et al., 2007). Therefore, appropriate spacing depends on variety, soil fertilization, cultivation season and other cultural practices. Keeping in view the above points, this study was carried out to determine the appropriate combination of organic and inorganic nitrogen sources and optimum plant spacing which could be a viable option to increase the yield of tomato in sustainable way.

2. Materials and Methods

The experiment was carried out at the Crop farm, Eastern University of Sri Lanka, Batticaloa during wet season. 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 was used comprising three different levels of nitrogen sources (N1- 75% IN + 25% ON, N2- 50% IN + 50% ON and N3- 25% IN + 75% ON) with three plant spacing (S1-80 cm × 35 cm, S2- 80 cm × 50 cm as recommended by the Department of Agriculture and S3- 80 cm × 80 cm). Each plot size was 4 m × 4 m.

Well developed, vigorous and uniform seedlings of tomato from the nursery were transplanted in field at three different plant spacing and 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 supplied through inorganic fertilizers. Plant height (cm), leaf area (cm^2/plant), biomass (kg. ha^{-1}) at harvesting stage and fresh fruit yield (Mt. ha^{-1}) were measured and analyzed by analysis of variance (ANOVA) and means were compared by Turkey's test at 5% probability level.

3. Results and Discussion

3.1 Effect of Plant Spacing on Plant Height

Plant height increases with decreasing plant spacing irrespective of nitrogen source. The highest plant height of 105 cm was observed at S1 (80 cm× 35 cm) while it was 99 cm at S3 (80 cm × 80 cm) at N1 nitrogen source (Fig. 1). Plant height reduces with increasing the amount of organic nitrogen source. Change in plant density has shining influences on plant height, where it increases by decreasing space between plants (Dahmardeh et al., 2010). It is also evidence that plant height of tomato increases at closer spacing than at wider spacing (Gupta and Shukla 1977; Mbinga, 1983). Higher number plants per unit area coupled with inter- plant competition could be attributed for increased plant height.

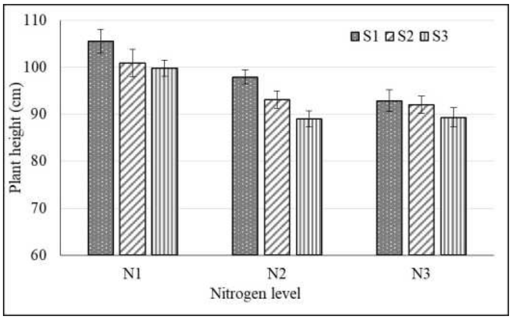

Fig. 1: Effect of different spacing on plant height at harvesting stage
Values are means ± SE of 3 replicates.

3.2 Effect of Nitrogen Source on Plant Height

Increased plant height was observed at higher proportion of inorganic nitrogen source (Fig. 2). Plant received 75% of IN + 25% ON (N1) produced highest plant height at all levels of spacing. It was observed that among all the nutrients required for plant growth and development, nitrogen (N) availability is often limiting factor. Inorganic nitrogen sources used in crop production increases available nitrogen to the plants. 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 (Gaskell and Smith, 2007). Plant receiving nitrate as N source had better plant growth and higher biomass than those receiving ammonium as N source (Gweyi-Onyango et al., 2009).

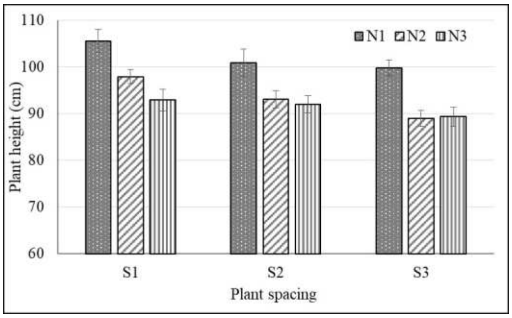

Fig. 2: Effect of different nitrogen source on plant height at harvesting stage
Values are means $\pm$ SE of 3 replicates.

3.3 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/plant) was produced by the plants belong to N1S3 followed by N2S3 (1361.11 cm^2/plant), while lowest leaf area (1042.33 cm^2/plant) was produced by the plants belong to N3S1. 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. Alsadon and Khalil (1993) also found that leaf area per plant increases with increasing N level. Widely spaced plants may produce higher number of leaves per plant as they have more environmental resources for growth than closely spaced plants (Miko and Manga, 2008).

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

Sources and levels of Nitrogen	Spacing	Leaf area (cm^2)
N1	S1	1200.56^{b}
	S2	1151.22^{b}
	S3	1450.78^{a}
N2	S1	1062.78 ^{b}
	S2	1295.22^{a}
	S3	1361.11^{a}
N3	S1	1042.33^{a}
	S2	1074.22^{a}
	S3	1069.89^{a}

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

3.4 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 N1S1 produced significantly highest plant biomass (2648.70 kg ha^{-1}) and fruit yield (27.93 Mt. 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.

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

Plant Spacing	Different levels of nitrogen sources	Plant biomass (kg/ha)	Yield (Mt/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 dissimilar letters within the spacing are significant ($p < 0.05$).

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 (Law-Ogbomo and Egharevba, 2009). It also influences on fruit weight of tomato (Sharma et al., 1999). Total yield and plant biomass were increased with reduced plant spacing. Studies conducted by Kirimi et al. (2011) and Abrha et al. (2015) have also reported higher fruit yield of tomato at closer spacing than wider spacing. Increase in plant number per unit area along with high availability of nitrogen could be attributed to the production of extra yield per unit area.

4. Conclusions

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 cm × 35 cm is the best option to increase the productivity of tomato (var. Thilina) in the eastern region of Sri Lanka.

Acknowledgement

We express our gratitude to the farm manager, technician and laboratory assistances for their kindly support without which this research study would not have been possible.

References

Abdel-Mawgoud, N.H.M, El-Greadly, Helmy, Y.I. and Singer, S.M. (2007). Responses of tomato plants to different rates of humic-based fertilizer and NPK fertilization. Journal of Applied Science Research 3(2): 169-74.

Abrha, H., Kebede, A., Amare, B. and Desta, M. (2015). Effect of Inter and Intra-Row Spacing on Yield and Yield Components of Tomato (Solanum lycopersicum Linn.) in South Tigray, Ethiopia. Journal of Natural Sciences Research 5(5):1-5.

Adekiya, A.O., Ojeniyi, S.O. and Agbede, M.T. (2012). Poultry manure effects on soil properties, leaf nutrient status, growth and yield of cocoyam in a tropical Alfisol. Nigerian Journal of Soil Science 22(2): 30-9.

Alsadon, A.A. and Khalil, S.O. (1993). Effect of Nitrogen Level on Two Tomato Cultivars under Plastic House Conditions. Journal of King Saud University, Agricultural Science 5(1).69-77.

Ara, N., Bashar, M.K., Begum, S. and Kakon, S.S. (2007). Effect of spacing and stem pruning on the growth and yield of tomato. International Journal of Sustainable Crop Production 2(3): 35-39.

Bodunde, J.G., Erinle, I.D. and Eruotor, P.G. (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.

Cezer, P.M. (2004). Organic fertilizer in rice: Myths and facts. A Public Education Series of the Asia Rice Foundation 1 (1):1-3.

Chukwu, L.I., Ano, A.O. and Asawalam, D.O. (2012). Effects of Poultry Manure and NPK fertilizer on soil properties and Nutrient uptake of maize (Zea mays L.) plants growth in an ultisol. Proceedings of the 36th Annual Conference of the Soil Science Society of Nigeria (SSSN) on 7th-11th March, 2012 University of Nigeria Nsukka.

Clark, M.S., Horwath, W.R., Shennan, C., Scow, K. M., Lantni, W.T. and Ferris, H. (1999). Nitrogen, weeds and water as yield-limiting factors in conventional, low-input, and organic tomato systems. Agriculture, Ecosystems and Environment 73(3):257-70.

Dahmardeh, M., Ramroodi, M. and Valizadeh, J. (2010). Effect of plant density and cultivars on growth, yield and yield components of faba bean (Vicia faba L.). African Journal of Biotechnology 9(50): 8643-47.

Gaskell, M. and Smith, R. (2007). Nitrogen sources for organic vegetable crops. HortTechnology 17(4):431–41.

Gupta, A. and Shukla, V. (1977). Response of tomato to plant spacing, nitrogen, phosphorus and potassium fertilizer. Indian Journal of Horticulture 34 (3): 270-6.

Gweyi-Onyango, J.P, Neumann, G. and Römheld, V. (2009). Effect of different forms of nitrogen on relative growth rate and growth components of tomato (Lycopersicon esculentum L.). African Journal of Horticultural Sciences.2:43-55.

Hooda, R.S., Singh, J., Mallk, Y.S. and Batra, V.K. (2001). Effect of planting geometry on fruiting behaviour of direct seeded tomato. Haryana Journal of Horticultural Sciences 31 (1-2). 111-3.

Kimani, N.G. (2007). Environmental Pollution and Impacts on Public Health: Implications of the Dandora Dumping Site Municipal in Nairobi, Kenya, United Nations Environment Programme, pp 1-31.

Kirimi, J.K., Itulya, F.M. and Mwaja, V.N. (2011). Effects of Nitrogen and Spacing on Fruit Yield of Tomato. African Journal of Horticultural Sciences 5:50-60.

Law-Ogbomo, K.E. and Egharevba, R.K.A. (2009). Effects of planting density and NPK fertilizer application on yield and yield components of tomato (Lycopersicum esculentum Mill) in forest Location. World Journal of Agricultural Sciences 5(2): 152-58.

Locascio, S.J., Hochmuth, G.J., Rhoads, F.M., Olsen, S.M., Smajstrla, A. G. and Hanlon, E.A. (1997). Nitrogen and potassium application scheduling effects on drip-irrigated tomato yield and leaf tissue analysis. HortScience 32 (2):230–35.

Mbinga, E.W. (1983). Pruning and Spacing Effect on Tomato var. Seeda Nam Khem. ARCTraining Report. pp 1-4.

Mehla, C.P, Srivastava, V.K, Singh, J. and Ram, M. (2000). Response of tomato (Lycopersicon esculetitum Mill.) varieties to N and P fertilization and spacing. Indian Journal of Agricultural Research 34(3):182-4.

Miko, S. and Manga, A.A. (2008). Effect of intra- spacing and nitrogen rates on growth and yield of sorghum (Sorghum bicolor L.) Var. ICSV 400. Journal of Process Analytical Technology (PAT) 4 (2): 66-73.

Okigbo, I. (2000). Application of organic and inorganic fertilizers and the response of maize crop. Nigerian Journal of Soil Science 18 (2). 22.

Sharma, K.C, Singh, A.K. and Sharma, S.K. (1999). Studies on Nitrogen and Phosphorus requirement of tomato hybrids. Annals of Agricultural Research 20(4): 339-402.

Usman, M., Madu, V.U and Alkali, G. (2015). The Combined Use of Organic and Inorganic Fertilizers for Improving Maize Crop Productivity in Nigeria. International Journal of Scientific and Research Publications 5(10):1-7.

Warner, J., Hao, X. and Zhang, T.Q. (2002). Effects of row arrangement and plant density on yield and quality of early, small-vined processing tomatoes. Canadian Journal of plant Science 2(4):765-70.