Asian Research Journal of Agriculture

11(4): 1-7, 2019; Article no.ARJA.52674
ISSN: 2456-561X

Effect of Mineral Nitrogen and Phosphorus Fertilizer Rates on Marketable Yield and Economic Return of Tomato (*Lycopersicon esculentum* Mil) at Northwestern Zone of Tigray

Yohannes Gebremichael[1*] and Gebremedhen Gebretsadikan[1]

[1]Shire-Maitsebri Agricultural Research Center, Shire, Tigray, Ethiopia.

Authors' contributions

This work was carried out in collaboration between both authors. Author YG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author GG managed the analyses of the study. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ARJA/2019/v11i430070
Editor(s):
(1) Dr. Rusu Teodor, Department of Technical and Soil Sciences, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania.
Reviewers:
(1) Mohamed Youssef Abed, Mansoura University, Egypt.
(2) Habu Saleh Hamisu, National Horticultural Research Institute, Nigeria.
Complete Peer review History: http://www.sdiarticle4.com/review-history/52674

Original Research Article

Received 02 September 2019
Accepted 08 November 2019
Published 06 December 2019

ABSTRACT

A field experiment was conducted to study the effect of different nitrogen and phosphorus fertilizer rates on the growth and yield tomato at Northwestern Zone of Tigray during 2016-2017 cropping season under irrigation condition. It is the most cultivated and high market value of vegetable crops in Tigray Northern Ethiopia. However, tomato production is limited due to low fertility of soil and inappropriate fertilizer rate. Six different levels of nitrogen (0, 23, 46, 69, 92 and 115 kg N /ha) and six different levels of phosphorus (0, 46, 69, 92,115 and 138 kg P_2O_5/ ha) were used and laid out in randomized complete block design with three replication. (Melkasalsa) tomato variety was used as a testing variety. The current findings showed that the highest marketable tomato fruit yield (61.16 t/ha) were obtained in 115 kg N/ha (250 kg urea/ha) and 92 kg P_2O_5 (200 kg Di Ammonium Phosphate DAP /ha). But, the profitable yield obtained was at N_2P_2 (46 kg N & 69 P_2O_5 kg ha^{-1}) that is 100 kg/ha of Urea combined with 150 kg/ha of DAP yield was obtained 48.25 t ha^{-1} and the profit was 235502 birr per ha with the maximum Marginal Rate of Return of 26.16%. Therefore, 100 kg/ha of urea with 150 kg/ha of DAP was recommended for the growers to improve tomato fruit productivity in the study area.

**Corresponding author: E-mail: aglovekb19@gmail.com;*

Keywords: Economic return; marketable yield; mineral fertilizer; tomato.

1. INTRODUCTION

Tomato (*Lycopersicon esculentum mill*) is one of the most widely grown solanaceae vegetable crops in the world. It is cultivated widely in all parts of the world and it is the largest in volume of production after potato and sweet potato [1]. Tomato is one of the most popular, important and widely used vegetable crops as ranked number two vegetable of the world after potato. It is considered a perennial crop, but for commercial productions it is cultivated as an annual crop [2].

It is one of the most important and widely grown vegetable in Ethiopia. Fresh, processing and cherry types are produced in the country [3]. Small-scale farmer produces the bulk of fresh market tomatoes. Processing types are mainly produced in large-scale horticultural farms. It is an important cash-generating crop to small-scale farmers and provides employment in the production and processing industries. It is also important source of vitamin A and C as well as minerals [4].

There is no definite time recorded regarding the introduction of tomato to Ethiopia. However, small cherry type tomato fruits have been produced for long around home gardens for home consumption and some extent a source of income. Lately different fruit types appeared around the big cities such as Addis Abeba, Nazret and Dre-Dawa. Recently farmers are interested in tomato production more than any other vegetable crop for its multiple purposes, such as it is a row material for industry, rich in vitamins and minerals can harvest 5-8 times/season, it is source of foreign currency, increase individual and national income and results high yield per unit area [5].

According to Lemma and shimeles [6] the total production of tomato in Ethiopia has shown a marked increase recently, indicating that it became the most profitable crop providing a higher income to small scale farmers compared to other vegetable crops. However, the national average of tomato fruit yield under farmers' conditions in Ethiopia is very low. A number of improved varieties and other agronomic packages have been recommended to farmers to overcome the low productivity and quality of tomato in the country. And yet, the average national yield still remains very low and reported to be about 7 ton/ha (CSA, 2009), which is less than 50% of the world average of 27 ton/ha.

The production and productivity of the crop in Ethiopia is influenced by different factors among which improper plant spacing and optimal fertilizer application are the major ones. Well decomposed farm yard manure, compost and chemical fertilizers could be used to increasing yield and yield quality of both fresh and processing tomatoes. The rate and method of application is important for efficient use of nutrients hence side dressing and foliar application (solution of macro & micro nutrients) are the important ones. Tomato plants produce stunted growth, small leaves & poor fruit yield if the plants are not properly nourished at different growth stages (vegetative, flowering &fruiting). In absence of well decomposed manure or compost farmers could apply different levels of NP fertilizers.

Mehla et al. [7] and Pandey et al., [8] reported that fruit yield in tomato is highly influenced by the NP fertilizers rates applied. Similarly, Sharma et al., [9] also reported average fruit weight of tomato has been influenced by the amount of NP fertilizers rates applied. Thus, tomato plant should receive optimum amount of NP fertilizers to produce higher fruit yields.

So far, in Ethiopia, the recommended fertilizer rate for Tomato is, 200 kg/ha DAP and 100 kg/ha for UREA (EARO, 2004). However, in the Northwestern Tigray farmers were used different rate of N and P fertilizer application. So, according to soil fertility and soil organic matter determine the optimum application fertilizer rate on Northwestern Tigray is very important.

1.1 Objectives

- To determine the optimum Nitrogen (N) and Phosphorus (P) Fertilizer rates for better tomato production with good economic return in Northwestern Zone of Tigray.

2. MATERIALS AND METHODS

The experiment was conducted on 2016-2017 G.C under irrigation condition in Northwestern Zone of Tigray Tselemti woreda on Shire-Maitsebri Agricultural Research Center (SMARC) experimental Station. The treatments consisted of six levels of nitrogen (0, 23, 46, 69, 92 and 115 kg N /ha) and six levels of phosphorus (0, 46, 69, 92,115 and 138 kg P_2O_5/ ha). We were

use Urea as the source of nitrogen and TSP (Triple Super Phosphate, P_2O_5) for phosphorus. The different rates of nitrogen were applied in two splits, 50% was applied at the time of transplanting and the rest 50% N was applied one months after transplanting and whole TSP (P_2O_5) was applied at the time of transplanting using drill application. The experiment was laid out as a randomized complete block design (RCBD) in 6x6 factorial arrangements with three replications. Each treatment combination was assigned randomly to the experimental units within a block. There were 36 plots corresponding to the 36 treatment combinations. The unit plot size of the experiment was 3.75 m x 3 m (11.25 m^2).The blocks were separated by a distance of 2m whereas the space between each plot within a block was 1.0 m. There were 5 rows in each plot with spacing of 75 cm between rows and 30 cm between plants and the central three rows were used for data collection, considering the two outermost rows as border. The testing variety was Melkasalsa. All management practices for the crop were applied uniformly as per the recommendation during nursery and filed conditions.

2.1 Method of Agronomic Data Collection

Marketable yield was collected from the central three rows by excluding plants from either end of the rows.

Total marketable fruit yield (kg ha^{-1}): Weight of healthy and marketable fruit yield per plot was determined and converted to kg ha^{-1}.

2.2 Method of Agronomic Data Analysis

All crop data collected in this study were subjected to two way statistical analysis of variance (ANOVA) following a procedure appropriate to randomized complete block design as suggested by [10]. When the treatment were significant, least significance differences (LSD) by Dunken's multiple range comparison were used for mean separation at p=0.05.

2.3 Method of Economic Data Analysis

Economic analysis of Nitrogen and Phosphorus fertilizer application and it was carried out for combined on tomato production data. The potential response of crop towards the added fertilizers and price of fertilizers during planting ultimately determined the economic feasibility of fertilizers application. The economic analysis was computed using the procedure described by CIMMYT [11].

Gross average seed yield (kgha^{-1}) (AvY): is an average yield of each treatment.

Adjusted yield (AjY): was the average yield adjusted downward by a 10% to reflect the difference between the experimental yield and yield of farmers [2].

$$AjY = AvY - (AvY*0.1)$$

Gross field benefit (GFB): was computed by multiplying field/farm gate price that farmers receive for the crop when they sale it as adjusted yield.

Total cost: was the cost of Urea and DAP and labor cost for application and including transportation cost used for the experiment. Their prices were based on 2016 and 2017 price during planting. The costs of other inputs and production practices such as labor cost for land preparation, planting, weeding, crop protection, and harvesting was assumed to remain the same or the difference was insignificant among treatments.

Net Benefit (NB): was calculated by subtracting the total costs from gross field benefits for each treatment.

$$NB = GFB - \text{total cost}$$

Marginal Rate of Return (MRR%): was calculated by dividing change in net benefit by change in cost which is the measure of increasing in return by increasing input.

$$\text{Marginal rate of return } (\%) = \frac{\text{Change in net benefit}}{\text{change in total cost}} \times 100$$

3. RESULTS AND DISCUSSION

3.1 Marketable Yield

The interaction effect of both nitrogen and phosphorous rates were found significant ($p<0.05$) on marketable fruit yield of tomato (Table-1). The result revealed that significantly highest marketable yield was obtained from the plots treated with higher amount of nitrogen and phosphorus (Table-1). Plots fertilized at the rate of 115 KgN/ha and 92 Kg of P_2O_5 /ha produced maximum marketable fruit yield of tomato i.e 61167 Kg/ha followed by 92KgN/ha and combined with 92 KgP_2O_5/ha. Almost similar results have been reported by Hegde [2], Shukla et al., [13], Porwal and Singh [14] that yield increased with increasing nitrogen levels. Results

are supported by the findings related to smaller and larger bulbs, as plots with greater number of larger sized bulbs resulted in higher yield.

On the above authors reported nitrogen showed significant differences in marketable tuber yield under the same phosphorus level indicating that the effect of different levels of phosphorus on marketable fruit yield is dependent on the levels of nitrogen. This may be due to the positive interaction and complementary effect between nitrogen and phosphorus in affecting and increasing the marketable tuber yield of potato in the study area. Similarly [15] reported without phosphorus application, nitrogen efficiency declined thereby indicating interaction between these nutrients.

3.2 Partial Budget Analysis

From the economic point of view, it was found that, the profitable yield was obtained from the combination of N_2P_2 (46 N & 69 P_2O_5 kg ha^{-1}) that is 100 kg/ha of Urea combined with 150 kg/ha of DAP and the obtained profit was 235502 birr per ha with the maximum Marginal Rate of Return of 26.16 (Table 2). Therefore, 100 kg/ha of urea is optimum with 150 kg/ha of DAP for the tomato production at North western zone of Tigray.

Table 1. Interaction effect of N& P fertilizers on marketable fruit yield of tomato

N(Kg/ha)	P_2O_5(Kg/ha)	Marketable yield(Kg/ha)
0	0	29799efg
	46	27388 g
	69	29286fg
	92	29760efg
	115	33888defg
	138	33972defg
23	0	36130cdefg
	46	47280abcd
	69	44301abcdefg
	92	48788abcd
	115	48589abcd
	138	42498bcdefg
	46	39864bcdefg
	69	48258abcd
	92	41355bcdefg
	115	54046ab
	138	46358abcdef
69	0	39580bcdefg
	46	47680abcd
	69	43697bcdefg
	92	46852abcde
	115	55052ab
	138	47613abcd
92	0	39936bcdefg
	46	52982abc
	69	44219abcdefg
	92	55336ab
	115	49057abcd
	138	48648abcd
115	0	43415bcdefg
	46	47635abcd
	69	47933abcd
	92	61167a
	115	53549abc
	138	45457abcdef
LSD		13973.9
CV (%)		34.0

Table 2. Economic analysis of nitrogen and phosphorus fertilizer rates application on tomato fruit yield production

S/N	Treatments	Fertilizer rate(Kg/ha)		Cost of fertilizer		Fertilizer application cost	Total variable cost(TVC)	Adjusted yield(Kg/ha)	Total revenue	Net revenue (TR-TVC)	Dominance	MRR (%)
		Nitrogen	phosphorus	Urea	DAP							
1	N0P0	0	0	0	0	0	0	26819.1	134095.5	134095.5	-	
2	N1P0	23	0	700	0	15	715	30517	152585	161870	-	24.86
3	N2P0	46	0	1400	0	30	1430	34309.8	171549	179119	-	25.19
4	N1P1	23	46	700	1600	45	2345	39509	197545	195200	-	26.05
5	N3P1	69	46	2100	1600	75	3775	42912	214560	210785	-	20.31
6	N2P2	46	69	1400	1600	60	3875	47875.4	239377	235502	-	26.16
7	N1P3	23	92	700	3200	75	3975	43909.2	219546	215571	-	20.50
8	N4P1	92	46	2800	1600	90	4490	47683.8	238419	233929	-	22.23
9	N2P4	46	115	1400	4000	105	5505	48641.4	243207	237702	-	18.82
10	N3P4	69	115	2100	4000	120	6120	49546.8	247734	241514	-	17.55
11	N4P3	92	92	2800	3200	120	6220	49802.4	249012	242892	-	17.49
12	N5P3	115	92	3500	3200	135	6835	55050.3	275251.5	268416.5	-	19.65

4. SUMMARY AND CONCLUSION

A field experiment was conducted to study the effect of different nitrogen and phosphorus fertilizer rates on the growth and yield tomato at Northwestern Zone of Tigray during 2016-2017 cropping season under irrigation condition. It is the most cultivated and high market value of vegetable crops in Tigray Northern Ethiopia. However, tomato production is limited due to low fertility of soil and inappropriate fertilizer rate. Six different levels of nitrogen (0, 23, 46, 69, 92 and 115 kg N /ha) and six different levels of phosphorus (0, 46, 69, 92,115 and 138 kg P_2O_5/ ha) were used and laid out in randomized complete block design replicated three times. Melkasalsa tomato variety was used as a testing variety.

The marketable yield of tomato and economic analysis were examined against the Nitrogen and Phosphorus fertilizer combinations. The Nitrogen and Phosphorus fertilizer interaction effect were obtained on tomato marketable fruit yield and economic return.

The highest marketable tomato fruit yield (61.16 t/ha*)* was obtained from the treatment combination of 115 kg N/ha (250 kg urea/ha) and 92 kg P_2O_5 (200 kg DAP /ha) (61.16 t/ha). But, the profitable yield obtained was at N_2P_2 (46N & 69 P_2O_5 kg ha^{-1}) that is 100 kg/ha of Urea combined with 150 kg/ha of DAP yield was obtained 48.25 t ha^{-1} and the profit was 235502 birr per ha with the maximum Marginal Rate of Return 26.16%.

Therefore, 100 kg/ha of urea with 150 kg/ha of DAP is recommended for the growers to improve tomato fruit productivity in the study area. Further studies are needed to identify the optimal rates of nitrogen and Phosphorus fertilizers for proper growth and production of tomato.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Dorjee B. Effect of pruning on yield and quality of indeterminate tomato. ARC-AVRDC, Kasetsart University, Thailand. 2000;1.
2. Abu-Alrub I. effect of different rates of nitrogen and phosphorus fertilizers on yield and quality of greenhouse tomato under the uae condition. EC Agriculture. 2019;5: 139-146.
3. Tesfay T, Gebremariam M, Gebretsadik K, Hagazi M, Girmay S. Tomato Yield and economic performance under vermin compost and mineral fertilizer applications. The Open Agriculture Journal. 2018;12(1).
4. Liu J, Hu T, Feng P, Wang L, Yang S. Tomato yield and water use efficiency change with various soil moisture and potassium levels during different growth stages. PloS one. 2019;14(3):e0213643.
5. Belachew B. Effect of nitrogen and phosphorus rates on growth, yield, yield components and quality of potato (*Solanum tuberosum* L.) at dedo, south west Ethiopia. Abstract. An M. Sc Thesis Presented to School of Graduate Study of Jimma University, Ethiopia; 2016.
6. Lemma Dessalegn, Shimeles Aklilu. Research Experience in Onion Production; 2003.
7. Mehla CP, Srivastava VK, Jage S, Mangat R, Singh J, Ram M. Response of tomato varities to N and P fertilization and spacing. Indian Jornal of Agricultural Research. 2000;34(3):182-184.
8. Pandey RP, Solanki PN, Saraf RK, Parihar MS. Effect of nitrogen and phosphorus on growth and yield of tomato varieties. Punjab Vegetable Grower. 1996;31:1-5.
9. Sharma KC, Singh AK, Sharma SK. Studies on Nitrogen and Phosphorus requirement of tomato hybrids. Annals of Agricultural Research. 1999;20(4):339-402.
10. Gomez KA, Gomez AA. Statistical procedures of agricultural research, second edition, Johan Wiley and Sons Inc. Toronto. 1984;680.
11. CIMMYT (International Maize and Wheat Improvement center). From agronomic data to farmer recommendations: An economics training manual. Completely revised edition, D.F, Mexico; 1988.
12. Hegde DM. Effect of irrigation and N fertilization on water relations, canopy temperature, yield and N uptake and water useof onion. Indian J. Agric. Sci. 1986;56: 858-867. Pandey UC, U. Ekpo. Response of nitrogen on growth andyield of onion (*Allium cepa* L.) in Maiduguri region of

Borno State. Niger. Res. Dev. Rep. 1991; 8:5-9.
13. Shukla V, Roa KPG, Prabhakar BS. Effect of nitrogen onbulb yield and keeping quality of onion cultivars. Prog. Hortic. 1989;21:244-245.
14. Porwal MK, Singh MM. Effect of nitrogen and weed management on onion (*Allium cepa*). Indian J. Agron. 1993;38:74-77.
15. FAO. Fertilizers and their Use. 4th Edn. International Fertilizer Industry Association, Rome, Italy; 2000.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/52674