Journal of Agriculture and Crops
ISSN(e): 2412-6381, ISSN(p): 2413-886X
Vol. 2, No. 3, pp: 24-30, 2016
URL: http://arpgweb.com/?ic=journal&journal=14&info=aims

Determination of Optimum Rates of N and P Fertilizer for Tomato at Mereb-lekhe District, Northern Ethiopia

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Abstract: A field experiment was conducted on at M.lekhe district (Ethiopia) during 2002 and 2003 years to investigate the response of tomato to rates of Nitrogen (N) and Phosphorus (P) fertilizers. The treatment consisted of factorial combination of four Nitrogen fertilizers rates (50 kg, 100 and 150 urea/ha) and four P rates (100,150 and 200 DAP/ha) arranged in a Randomized Complete Block Design. Statistically significant and highest yield per plant was recorded at the highest rate of DAP (200 kg/ha). The significantly lowest yield was found at the zero level (with out DAP applied). The marketable yield in Q/ha of the rates is 939.96, 822.44, 731.1067 and 421.44 for 200, 150, 100 and 0 rates respectively. As the partiual budget analisis showed increasing rate of phosphorus and urea fertilizers increased profitability until 200 kg/ha and 150 kg/ha respectively.
Keywords: Fertilizer, Rate and Yield.

1. Introduction

Tomato (Lycopersicon esculentumL.) is the most widely grown vegetable in the world being recognized as a reach source of vitamins and minerals. It is also among the most important vegetable crops in Ethiopia. The total production of this crop in the country has shown a marked increase (Lemma *et al.*, 1992) since it became the most profitable crop providing a higher income to small scale farmers compared to other vegetable crops. However, tomato production is highly constrained by several factors especially in developing nations like Ethiopia. The national average of tomato fruit yield in Ethiopia is often low (125 q/ha) compared even to the neighboring African countries like Kenya (164 q/ha) (FAO Production Year Book, 2004). Current productivity under farmers' condition is 90 q/ha, whereas yield up to 400 q/ha can be recorded on research plots (personal communication).

In Ethiopia, farmers get lower yield mainly due to diseases and pests as well as due to sub-optimal fertilization. Mehla *et al.* (2000) reported that fruit yield in tomato is highly influenced by the NP fertilizers rates applied. Similarly, Sharma *et al.* (1999) also reported average fruit weight of tomato to have 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.

According to (http://www.avrdc.org, 2007) the total nitrogen (kg ha-1) required to achieve a target fruit yield is estimated by multiplying the target yield in tons per hectare by 2.4. Similarly, P2O5 requirement per hectare can be estimated by multiplying N requirement by 0.35 (http://www.avrdc.org, 2007).

Improper plant spacing is also among the notable reasons of low productivity of this crop. Lemma *et al.* (1992) reported that plant spacing greatly influenced fruit yield in both fresh market and processing tomatoes. Likewise, Mehla *et al.* (2000) also reported yield parameters in tomato to have been affected by spacing.

In Ethiopia, so far plant spacing and fertilizer rates were determined for tomatoes only at Melkasa research center which can not agro-ecologically represent the other tomato growing regions of the country and especially no such study was done in tomatoes under vertisol condition and the whole of such previous agronomic studies were confined only to sandy loam soils of the rift valley regions of the country. Although the tomato growers in the rift valley regions can directly use the recommendation from this research center, the same recommendation however, can not apply for the other tomato growing regions with completely different agro-ecology. In tropics in general, the common fertilizer application rates according to literature are 60-120 kg N, and 60-140 kg P2O5and 60-120 kg K2O per hectare (http://www.avrdc.org, 2007). However, this would also be too general to use for specific regions. Since spacing requirement of tomato depends on soil type and its inherent fertility (Lemma *et al.*, 1992) and the type of cultivars (Mehla *et al.*, 2000) the use of blanket recommendation would be inappropriate and it would be indispensable to identify appropriate recommendation for specific soil types and cultivars grown in the region. Thus, the present investigation was proposed with an objective to determine an optimum fertilizer rate with contrasting growth habits grown in vertisol dominated region of the central Ethiopia.

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1.1. Objective:

- To determine the appropriate fertilizer application rate for maximum yield and minimum cost.

2. Materials and Methods

The experiment was conducted in irrigation sites of wereda M/lekhe. This area is located about 42km north of Adwa town in the Ethio-Eritrea border. The area is located in Mereb-Lekhe Woreda, Central Zone of Tigray in the Ethio-Ertirean border at an altitude of 1390m.a.s.l. It is located at a distance of 77km away from Axum towards the North-Eastern. It is located at a latitude of $14^0$409'38"N and longitude of $38^0$735'45"E in semi-arid tropical belt of Ethiopia with a hot to warm 'kola' agro climatic zone predominantly arid to semi-arid. The rainy season of the study area is mono-modal with erratic and torrential rainfall. The mean minimum and maximum monthly temperature ranges from 12.13^0c to 27.88^0c, respectively. And the soil is sandy loam. It is potential area for horticultural crops production with a wider diversity. Its farmers grow fruits of tropical types, vegetables, cereals, oil crops and preserve many lowland trees. Famers often grow fruits such as orange, mango, banana, papaya, and lemon; vegetables such as tomato, hot pepper, lettuce, onion, and shallot; oil crops such as groundnut and cereals such as sorghum, maize, finger millet, and Teff. Tomato is the major vegetable crop ever grown in small scale irrigation scheme of the diversion.

2.1. Treatments Design and Management

The treatment consisted of factorial combination of T four levels of nitrogen rates **(0, 50, 100 and 150)** Vs four levels of Phosphorus rate **(0, 100, 150_3 and 200)** where **Po** and **No** are control levels giving 25 total treatments. The experiment was arranged in randomized complete block design (RCBD).

Seedlings grown on seed bed for one month. Then seedlings transplanted to prepared ridges in spacing of 30 cm and 100 cm for plants and rows respectively. Irrigation and other cultural practices done according the need of the crop. P fertilizer applied during transplanting and the N fertilizer applied in split (half during transplanting and the half after 6 weeks).

3. Result and Discussion

Table-1. Main Effect of DAP and Urea on tomato phenology & growth parameters in 2002 E.C

Main Effect Treatment	Days to 50% Flowering	Days to 50% Maturity	Plant Height (cm)	No. Of Branches/plant
DAP				
0	33.00 a	75.08	45.95	5.17
100	31.00 b	75.00	42.35	5.29
150	31.41 b	74.91	42.24	5.12
200	31.41 b	75.08	48.98	5.92
Prob	0.0073	0.99	0.10	0.1119
SE	0.4117	0.40	2.18	0.2552
CV	4.95	1.72	17.38	18.30
Urea				
0	32.17	75.00	42.01	4.65 b
50	31.75	74.75	46.35	5.70 a
100	31.58	75.33	44.68	5.51 ab
150	31.33	75.00	46.49	5.64 a
Prob	0.54	0.78	0.44	0.0207
SE	0.41	0.40	2.18	0.2552
CV	4.95	1.72	17.38	18.30

Table-2. Interaction Effect of DAP and Urea on tomato phenology & growth parameters in 2002 E.C

Treatment (DAP & Urea)	Days to 50% flowering	Days to 50% maturity	Plant Height (cm)	No. Of Branches/plant
0*0	32.67	74.33	46.53	4.77
0*50	33.00	74.33	45.53	5.77
0*100	33.00	75.67	46.40	5.33
0*150	33.33	76.00	45.37	4.80
100*0	32.00	75.00	38.00	4.84
100*50	30.67	75.33	46.83	5.94
100*100	30.67	75.00	42.17	4.77
100*150	30.67	74.67	42.43	5.61
150*0	32.33	75.67	36.10	3.99
150*50	31.33	74.67	43.70	5.09
150*100	30.67	75.00	40.83	5.57
150*150	31.33	74.33	48.33	5.83
200*0	31.67	75.00	47.40	5.03
200*50	32.00	74.67	49.37	6.00
200*100	32.00	75.67	49.33	6.34
200*150	30.00	75.00	49.83	6.32
Prob.	0.7533	0.8384	0.9484	0.6095
SE	0.8579	0.8333	4.6963	0.5213
CV	4.95	1.72	17.38	18.30

Late flowering of tomato was observed at P-fertilizer rate of 0 kg/ha. Otherwise, the different rates of P-fertilizer did not show significant effect on maturity, plant height and Number of branches per plant. The different N-fertilizer rates show significant effect on number of branches per plant and significantly smaller number branches per plant was observed from plots receiving no N-fertilizer. No significant interaction effect of the different N and P fertilizer rates on these parameters.

Table-3. Main Effect of DAP & Urea on tomato yield components in 2002 E.C

Main Effect Treatment	No. Of Clusters/plant	No. of Matured Fruits/plant	Fruit length (cm)	Fruit Diameter (cm)
DAP				
0	11.33	26.94	6.57	4.19
100	9.91	25.37	6.54	4.36
150	11.48	26.51	6.57	3.98
200	14.08	33.05	6.69	4.26
Prob	0.06	0.08	0.84	0.23
SE	1.05	2.24	0.13	4.20
CV	33.58	30.97	6.73	11.60
Urea				
0	9.63	21.93 b	6.33	3.95
50	12.72	28.56 ab	6.63	4.24
100	11.99	30.31 ab	6.67	4.13
150	12.49	31.07 a	6.74	4.47
Prob	0.16	0.025	0.12	0.05
SE	1.05	2.24	0.13	0.13
CV	33.58	30.97	6.73	11.60

Table-4. Interaction Effects of DAP and Urea on tomato yield components in 2002 E.C

Treatment (DAP & Urea)	No. Of Clusters/plant	No. of Matured Fruits/plant	Fruit length (cm)	Fruit Diameter (cm)
0*0	10.50	25.17	6.41	3.97
0*50	13.22	27.94	6.58	4.50
0*100	11.11	28.39	6.610	4.25
0*150	10.50	26.28	6.70	4.06
100*0	7.87	18.39	6.21	4.02
100*50	9.83	24.94	6.73	4.25
100*100	10.33	27.50	6.43	4.08
100*150	11.61	30.68	6.81	5.07
150*0	8.67	16.61	6.25	3.68
150*50	12.17	27.39	6.73	4.12
150*100	11.83	28.22	6.75	3.91
150*150	13.28	33.83	6.55	4.21
200*0	11.44	27.55	6.46	4.12
200*50	15.67	34.00	6.50	4.08
200*100	14.67	37.16	6.91	4.30
200*150	14.55	33.50	6.916	4.55
Prob.	0.1025	0.9241	0.9573	0.4952
SE	2.3184	4.8116	0.2748	0.2646
CV	33.58	30.97	6.73	11.60

No significant main and interaction effects of the different rates of N and P-fertilizers on the yield components of tomato except that higher rate of N-fertilizer resulted in significantly higher number of matured fruits per plant.

Table-5. Main Effects of DAP and Urea on Tomato Yield in 2002 E.C

Main Effect Treatment	Wt of Marketable Fruits (kg/plant)	Wt of unmarketable fruits (kg/plant)	Wt of marketable Fruits (kg/ha)	Wt of unmarketable Fruits (kg/ha
DAP				
0	0.71	0.13	18520	3295
100	0.56	0.12	18645	3680
150	0.60	0.10	17098	3496
200	0.78	0.10	22880	3326
Prob	0.1017	0.9486	0.3041	0.3277
SE	0.0677	0.0436	2229	409.94
CV	26.71	23.04	29.63	20.19
Urea				
0	0.56	0.14	16083	2761
50	0.67	0.12	20802	4027
100	0.72	0.09	21453	4005
150	0.72	0.10	20807	4005
Prob	0.3008	0.8075	0.3057	0.0886
SE	0.0677	0.0436	2229	409.94
CV	26.71	23.04	29.63	20.19

Table-6. Interaction effect of N and P Fertilizer on tomato Marketability in 2002 E.C

Treatment (DAP & Urea)	Wt of Marketable Fruits (kg/plant)	Wt of unmarketable fruits (kg/plant)	Wt of marketable Fruits (kg/ha)	Wt of unmarketable Fruits (kg/ha)
0*0	0.66	0.32	20083	3300
0*50	0.73	0.06	19875	3895
0*100	0.78	0.07	22270	3425
0*150	0.69	0.08	19854	2562
100*0	0.41	0.05	13812	2200
100*50	0.58	0.25	20729	3837
100*100	0.60	0.083	21541	4683
100*150	0.68	0.09	18500	4000
150*0	0.43	0.10	12416	2325
150*50	0.62	0.08	19770	3883
150*100	0.57	0.10	16000	3429
150*150	0.77	0.11	20208	4350
200*0	0.73	0.10	18020	3220
200*50	0.73	0.10	22833	4491
200*100	0.92	0.10	26000	4483
200*150	0.74	0.12	24666	5108
Prob.	0.9614	0.5004	0.9930	0.8279
SE	0.1468	0.0878	4913	863.83
CV	26.71	23.04	29.63	20.19

No significant main and interaction effects of the different rates of N and P-fertilizers on the marketable and non-marketable yield of tomato.

Table-7. Effect of DAP fertilizer on different growth and yield parameters of Tomato in 2003 E.C

DAP rate	Days to maturity	Plant height	No of Branches /plant	No of Cluster /plant	No of Fruits /plant	Marketable yield (g/p)	Unmarketable yield (g/p)	Fruit length (cm)	Fruit diameter (cm)
0	86.2500^{a}	34.942^{b}	3.9833^{b}	4.075^{d}	14.600^{c}	316.08c	62.03^{c}	6.5167	3.7667^{b}
100	79.4167^{b}	35.325^{b}	4.5083^{ab}	6.1167^{c}	21.942^{b}	548.33^{b}	117.11^{b}	6.2917	3.9667^{ab}
150	78.9167^{b}	37.533^{ab}	4.6^{a}	7.3^{b}	23.208^{ab}	616.83^{ab}	129.99^{b}	6.3333	4.0250^{ab}
200	76.7500^{c}	40.067a	4.6417^{a}	8.6083^{a}	26.075^{a}	704.97^{a}	164.08^{a}	6.4417	4.1500^{a}
LSD	*1.8702*	*0.5382*	*1.0919*	*1.0919*	3.7346	137.13	33.22	*ns*	0.2708
CV	2.788229	10.50291	14.53959	20.04194	20.84625	30.04857	33.63076	6.504033	8.155962

The interaction effect of DAP and Urea fertilizers did not show any significant different in all parameters. However there were significant differences among the different levels of DAP and Urea. With no DAP application the days to maturity was significantly higher, while the least was on 200 kg/ha. The number of clusters per plant also was significantly highest at 200 kg/ha. Highest number of fruits per plant was found at 200 kg/ha but not statistically difference from 150 kg/ha. Statistically significant and highest yield per plant was recorded at the highest rate of DAP (200 kg/ha). The significantly lowest yield was found at the zero level (with out DAP applied). The marketable yield in Q/ha of the rates is 939.96, 822.44, 731.1067 and 421.44 for 200, 150, 100 and 0 rates respectively.

Table-8. Effect of Urea fertilizer on different growth and yield parameters of Tomato in 2003 E.C

Urea rate	Days to maturity	Plant height	No of Branches /plant	No of Cluster /plant	No of Fruits /plant	Marketable yield (g/p)	Unmarketable yield (g/p)	Fruit length (cm)	Fruit diameter (cm)
0	80.0833	35.775	4.3000	5.6833[b]	17.925[b]	431.64[b]	93.83[b]	6.1917[b]	4.0083a
50	79.8333	37.883	4.5167	6.5750[ab]	22.100[a]	563.45[ab]	124.14[ab]	6.3667[ab]	3.9250a
100	80.2500	36.525	4.6167	6.8833[ab]	22.392[a]	582.54[a]	124.48[ab]	6.4250[ab]	3.9083a
150	81.1667	37.683	4.3000	6.9583[a]	23.408[a]	608.57[a]	130.78[a]	6.6000[a]	4.0667a
LSD	*ns*	*ns*	*ns*	*1.0919*	*3.7346*	*137.13*	*33.22*	*0.3473*	*ns*
CV	*2.788229*	*10.50291*	*14.53959*	*20.04194*	*20.84625*	*30.04857*	*33.63076*	*6.504033*	*8.155962*

There is no significant difference among the levels of Urea for the growth parameters. The maximum cluster per plant was observed at the highest rate of urea applied. But statistically similar with 100 kg/ha and 50 kg/ha rates. Statistically least number of fruits per plant was observed at the zero rate of urea. A similar result was observed for marketable yield.

Table-9. Partial budget analysis of tomato produced by applying phosphorus fertilizer E.C

Fertilizer Rate (kgP_2O_5/ha)	Fertilizer Cost (Birr)	Fertilizer Application & Transport Cost [Birr]	Total variable cost (TVC) [Birr]	Fruit yield (Q/ha)	Total Revenue (TR) [Fruit yield *600]	Net Revenue [TR-TVC]	Marginal Rate of return (ratio)	Marginal Rate of return (%)
0	0	0	0	190	114000	114000		
							40	4000
100	1200	25	1225	275	165000	163775		
							21.5	2150
150	1800	50	1850	298	179100	177250		
							47.5	4750
200	2400	75	2475	349	209400	206925		

Table-10. Partial budget analysis of tomato produced by applying urea fertilizer

Fertilizer Rate (kgP_2O_5/ha)	Fertilizer Cost (Birr)	Fertilizer Application & Transport Cost [Birr]	Total variable cost (TVC) [Birr]	Fruit yield (Q/ha)	Total Revenue (TR) [Fruit yield *600]	Net Revenue [TR-TVC]	Marginal Rate of return (ratio)	Marginal Rate of return (%)
0	0	0	0	223	133800	133800		
							32	3200
50	1200	25	1225	291	174600	173375		
							7.8	780
100	1800	37	1837	300	180000	178163		
							7.8	780
150	2400	50	2450	309	185400	182950		

As indicated the partial budget analysis at the above two tables, increasing rate of phosphorus and urea fertilizers increased profitability until 200 kg/ha and 150 kg/ha respectively.

4. Conclusion and Recommendation

The two years result of the research showed that application of phosphorus and urea fertilizers is quite important for tomato production. The rate of application is also determinant for productivity and profitability. Moreover, a50 kg/ha urea fertilizer and 200 kg/phosphorus fertilizer could be suggested to apply. Therefore these can be used as one package of tomato production technology and all growers better to apply.

References

Lemma, D., Yayeh, Z. and Herath, E. (1992).'Agronomic studies in tomato and capsicum. Herath and Lemma (eds.). Horticulture Research and Development in Ethiopia'.*Proceedings of the Second National Horticultural Workshops of Ethiopia.*Addis Ababa, Ethiopia.

Mehla, C. P., Srivastava, V. K., Jage, S., Mangat, R., Singh, J. and Ram, M. (2000). Response of tomato varities to N and P fertilization and spacing. *Indian Jornal of Agricultural Research,* 34(3): 182-84.

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.