Response of Irrigated Tomato (Lycopersicon esculentum L.) to Nitrogen and Phosphorus Fertilizers at Megech Irrigation Scheme, North Gondar

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Abstract

Nitrogen (N) and phosphorus (P) fertilizer recommendations for irrigated tomato production is lacking for the different irrigation schemes in the Amhara region. An experiment was conducted in 2010 and 2011 at Megech to determine economically feasible nitrogen and phosphorus fertilizer levels for irrigated tomato. Factorial combinations of four levels of nitrogen fertilizer (0, 50, 100, and 150 kg N ha^{-1}) and four levels of phosphorus fertilizer (0, 20, 40, 60 kg P ha^{-1}) constituted the treatments. The experimental design was randomized complete block in three replications. Tomato variety Roma VF was used. Results showed that based on the biological yield and partial budget analysis, application of 150 kg N ha^{-1} and 60 kg P ha^{-1} were found high yielding and economically feasible and are recommended for tomato production in Megech irrigation scheme and other similar areas.

Key words: N and P fertilizers, Tomato, Megech,

Introduction

Tomato (*Lycopersicon esculentum* L.) 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). However, tomato production is highly constrained by several factors, especially in developing nations like Ethiopia. The national average tomato fruit yield in Ethiopia is often low (12.5 t ha^{-1}) compared to the neighboring African countries like Kenya (16.4 t ha^{-1}) (FAO, 2004). Current qspevdujwjuz! voefs! gbsnfst! dpoejujpo! jt! :.0 t ha^{-1}, while yields up to 40.0 t ha^{-1} were recorded on research plots (Tesfaye, 2008).

In Ethiopia, farmers get lower yield mainly due to diseases and pests, as well as due to sub-optimal fertilization. Nitrogen and phosphorus are the two essential macronutrients for plants. Their deficiency as well as excess levels may change plant functions (Glass *et al*., 2002; Mahmud *et al*., 2003). Normally fertilizer is applied at planting time of tomato in irrigated areas but most of the farmers in irrigated areas usually apply less or no fertilizer in order to avoid losses in case of crop failure. Moreover, the fertility status of the soil is depleted due to continues cropping of cereals without any fertility restoration effort. The current government policy on agricultural development emphasizes on producing high value and marketable crops with efficient soil and water management. Hence, farmers are being encouraged to grow high value crops like vegetables, fruits, spices and high yielding cereals using irrigation. Furthermore, with the increasing irrigation scheme development in the area tomato is becoming an important crop. However, fertilizer rates required for irrigated tomato were not yet determined for the area. The objective of this research was, therefore, to determine economically feasible rate of nitrogen and phosphorous fertilizers for irrigated tomato production in Megech irrigation scheme.

Materials and Methods

Description of Study Area

Gjfme! fyqfsjn fout! x fsf! dbssjfe! pvu! jo! 3121! boe! 3122! po! gbsn fst ! gield at Megech irrigation command area, Dembia district. The experimental site is located at $12^0$31 62‘! N latitude and $37^0$31 34‘! F! mpohjuvef! boe! bu elevation of 1786 to 1800 m above sea level. The study area is characterized by homogeneous flat topography, with slope of 1% to 2%. The soil is dominantly Vertisols (>65% coverage) with few coverage of Luvisols. The top 60 cm soil of the experimental site is clay in texture with 11% sand, 38% silt and 51% clay content. It has 0.1% total nitrogen, 1.1% organic carbon, 24.2 ppm available phosphorous and a pH of 8. The soil has 1.41 g cm^{-3} bulk density, 44.5% field capacity, and 27.5% permanent wilting point (MoWR, 2008). Agro-ecologically, the study area is in a tepid thermal zone and moist to sub-humid moisture zone (180 220 day growing period), termed as tepid moist and sub humid lowland (MoA, 1998). The mean annual potential evapotranspiration is about 1560 mm. Mean maximum and minimum annual temperatures are 27 ^{O}C and 13 ^{O}C, respectively and the mean annual temperature is 19 ^{O}C.

Experimental Design and Procedures

The experiment was conducted at on-farm. Treatments were factorial combinations of four nitrogen fertilizer levels (0, 50, 100, and 150 kg N ha^{-1}) and four phosphorus levels (0, 20, 40, 60 kg P ha^{-1}). The experimental design was randomized complete block in three replications. The plot size was 3 m*3 m, and the spacing between blocks and plots was 1.5 m and 1 m, respectively. Tomato variety Roma VF was used as test crop, where the spacing between rows and between plots was 75 cm and 30 cm respectively. Urea and TSP were used as sources of nitrogen and phosphorus fertilizers, respectively. Phosphorus was band-applied at planting, while nitrogen was applied in split, half at planting and the remaining half at 45 days after transplanting. Irrigation water was supplied weekly with furrow system.

The yield and yield component data were subjected to statistical analysis using SAS statistical package. Whenever the variance analysis revealed significant treatment differences, means were separated using LSD test at 5% probability level. Partial budget analysis was also done using the market price data collected at Kola Diba town, Denbia. The mean price of tomato was 3.0 ETB kg^{-1}, mean price of Urea was 9.87 ETB kg^{-1}, and mean price of phosphorus was 10.5 ETB kg^{-1}. Yields were adjusted down by 10% up!csjoh!epxo!zjfme!up!gbsnfst!qspevdujwjuz!mfwfm

Results and Discussion

Results of the combined ANOVA showed that number of fruits per plant responded only to the main effects of nitrogen. Fruit weight responded neither to the nitrogen and phosphorus effects nor to the interaction. Tomato fruit yield responded to the main effects of nitrogen and phosphorus fertilizers (Table 1).

Fruit number per plant was significantlz!) 1/16!ijhifs!gps!bmmojusphfo!gfsujmjfs!mfwfmt! pwfs!uif!dpouspm)Ubcmf!3/!Upnbup!gsvju!zjfme!xfsf!tjhojgjdbouz!) 1/12!ijhifs!xjui! the application of 150 kg N ha^{-1} and 40 and 60 kg P ha^{-1} (Table 2). Fruit yield increased following the increase in the N level. Similarly, fruit yield tended to follow the increase in P level; although fruit yield at 40 kg P ha^{-1} did not significantly differ from fruit yield at 60 kg P ha^{-1}. Higher total fruit yield in tomato at higher N and P rate was reported by several researchers (Pandey *et al*., 1996; Tesfaye, 2008; Mehla *et al*., 2000), which is in agreement with the present finding. The higher marketable fruit yield under higher N and P rate might have been achieved probably because the higher N and P rate might have improved fruit size thereby contributing to greater marketable fruit yield per plot.

Table 1. Combined ANOVA for the effect of N and P fertilizers on the yield and yield components of tomato at Megech (2010 and 2011).

Source of variation	df	Mean square		
		Number of fruit per plant	**Fruit weight**	**Yield**
Nitrogen (N)	3	924.6*	12.8ns	433.9**
Phosphorus (P)	3	62.8ns	6.2ns	138.6**
N x P	9	8.6ns	7.1ns	10.2ns
Error	78	228.7	89.6	12.3

Table 2. Effect of nitrogen and phosphorous fertilizer on the yield and fruit number of tomato at Megech combined over years (2010 and 2011).

Treatment	Fruit number plant^{-1}	Marketable Yield (t ha^{-1})
N level (kg ha^{-1})		
0	22.6^{b*}	21.2^{d}
50	30.8^{ab}	25.6^{c}
100	34.7^{a}	28.6^{b}
150	36.6^{a}	31.1^{a}
P level (kg ha^{-1})		
0	29.1	23.4^{c}
20	30.8	26.1^{b}
40	32.4	28.2^{a}
60	32.5	28.7^{a}
LSD (0.05)	8.69	2.02
CV (%)	48.5	13.2

**Means followed by the same letters were not statistically significant at P 0.05.*

Results of the partial budget analysis indicated that the marginal rate of return was higher with the application of 150 kg N ha^{-1} and 60 kg P ha^{-1} (Table 3). Thus, based on the biological yield response and partial budget analysis maximum and profitable marketable yields of tomato at Megech could be obtained with the application of 150 kg N ha^{-1} and 60 kg P ha^{-1}.

Table 3. Partial budget analysis for the effect of nitrogen and phosphorus fertilizers on the yield of tomato at Megech irrigation scheme.

	Nitrogen level (kg ha^{-1})				**Phosphorous level (kg ha^{-1})**			
	0	**50**	**100**	**150**	**0**	**20**	**40**	**60**
Mean yield (t ha^{-1})	21.2	25.6	28.6	31.1	23.4	26.1	28.2	28.7
Adjusted yield (t ha^{-1})	19.1	23.0	25.7	28.0	21.1	23.5	25.4	25.8
Total Revenue (ETB ha^{-1})	95400	115200	128700	139950	105300	117450	126900	129150
Total costs (ETB ha^{-1})	17700	17700	17700	17700	17700	17700	17700	17700
Gross benefit (ETB ha^{-1})	77700	97500	111000	122250	87600	99750	109200	111450
Cost that vary (ETB ha^{-1})	0	1073	2146	3218	0	1073	2146	3219
Net benefit (ETB ha^{-1})	77700	96427	108854	119032	87600	98677	107054	108232
Dominance Analysis								
Marginal cost (ETB ha^{-1})	0	1073	1073	1073	0	1073	1073	1073
Marginal net benefit (ETB ha^{-1})	0	18727	12427	10177	0	11077	8377	1177
Marginal rate of return (%)		1746	1158	949		1033	781	110

Conclusion and Recommendations

Tomato yield has responded to nitrogen and phosphorus application in Megech. The increase in yield in response to nitrogen fertilizers could probably be due to enhanced increase in leaf area which could result in higher photo assimilates. Based on the biological yield and partial budget analysis, maximum and profitable marketable yields were obtained when 150 kg N ha^{-1} and 60 kg P ha^{-1} were applied. Thus, it is recommended that farmers in the Megech irrigation command area and similar agroecology should apply 150 kg N ha^{-1} and 60 kg P ha^{-1} for maximum and profitable tomato production under irrigation.

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