Response of Irrigated Hot Pepper to Nitrogen and Phosphorus application at Rib

[1]*Birhanu Agumas, [1]Anteneh Abewa and [1]Dereje Abebe

[1]Adet Agricultural Research Center. P.O.Box: 08, Bahir Dar, Ethiopia

*Corresponding author, birhanuagumas1980@gmail.com

Abstract

A field experiment was conducted for two years (2011 and 2012) to determine the optimum amount of nitrogen (N) and phosphorus (P) fertilizers for hot pepper (Capsicum frutescens) at Rib under irrigation. The experiment was comprised of a factorial combination of five rates of nitrogen (46, 69, 92, 115,138 kg ha^{-1}) and three rates of phosphorus (20, 30 and 40 kg ha^{-1}). Additionally one treatment without N and P was included as a negative control. The treatments were arranged in a randomized complete block design with three replications. Phosphorus was applied at transplanting while nitrogen was applied in two splits i.e. half at transplanting and half at early flowering. The result showed that the marketable yield was significantly increased by N and P. The highest yield in 2011 (26460 kg ha^{-1}) was obtained from 115 kg N ha^{-1} and 40 kg P ha^{-1} and in 2012 (27857 kg ha^{-1}) was obtained from 115 kg N ha^{-1} and 20 kg P ha^{-1}. The partial budget analysis also showed that applying 115 kg N and 20 kg P ha^{-1} had the highest net benefit (67753.22 ETB ha^{-1}) and MRR of 2011.46 % followed by 46 kg N ha^{-1} and 30 kg P ha^{-1} with a net benefit of 67019.65ETB and MRR of 389.31%. Thus, 115 kg N and 20 kg P ha^{-1} are recommended for pepper for Rib and similar agro-ecologies under irrigation.

Keywords: hot pepper, nitrogen and phosphorus, optimum rate, marketable yield

Introduction

Pepper is belonged to the solanaceous group of plants along with tomatoes, eggplants and some other ornamental plants. It has been a part of the human diet since about 7500 BC (Mac Neish, 1964 cited in Sileshi, 2011). Because of its wide use in Ethiopian diet, the hot pepper is an important traditional crop mainly valued for its pungency and color. The crop is also one of the important spices that serve as the source of income particularly for smallholder producers in many parts of rural Ethiopia. According to the EEPA (2003 cited in Sileshi, 2011), in the major pepper producing regions in the country, that is, Amhara, Southern Nations and Nationality People's Regional State (SNNP) and Oromia, pepper generated an income of 122.80 million Birr for farmers in 2000/01. This value jumped to 509.44 million Birr for smallholder farmers in 2004/05. This indicates that hot pepper serves as one of the important sources of income to smallholder farmers and as exchange earning commodity in the country (Beyene and David, 2007 cited in Sileshi, 2011).

Peppers is a heavy f4F000C76u2>-9<(0C76u2>-9<lP)] T</MCID 2/(that)-109(se)3(rv)-6(e)i3051>-9BT1 p2/(t

higher productivity, and at the precise rates that match the specific growing conditions. In Ethiopia, the blanket recommended fertilizer rate for the hot pepper is, 200 kg ha^{-1} DAP and 100 kg ha^{-1} for urea (EARO, 2004 cited in Sileshi, 2011) for the rainfall condition soil and environmental conditions site specific recommendation under irrigation is vital. However, there was no recommended fertilizer rate for hot pepper under irrigation. Therefore, the objective of this research was to determine site specific optimum nitrogen and phosphorous fertilizer rates for Rib and similar agro-ecologies under irrigation.

Materials and methods

Description of the study site

The experiment was conducted at Rib which is found in Fogera district situated at 11^0 41' to 12^0 02' N latitude and 37^0 29' to 37^0 59' E longitude at an altitude of 1800 m a.s.l. The soil of experimental site was Fluvisols. According to the classification made by Bruce and Rayment (1982), the available phosphorus content of the soil was high while the total nitrogen content was low to very low (Table 1). Cation exchange capacity (CEC) was also high based on the category recommended by Hazelton and Murphy (2007).

Table 1. Chemical soil properties for the testing sites

Sample	Available Phosphorus (ppm)	Total Nitrogen (%)	CEC (cmol kg^{-1})
Farmers' field	24.32-36.71	0.003-0.18	33.00-36.25

Experimental design and procedures

The experiment was conducted on farmers' field for two consecutive years 2011 and 2012. Five rates of N (46, 69, 92, 115,138 kg ha^{-1}) and three rates of P (20, 30 and 40 kg ha^{-1}) were tested in factorial arrangement including a control treatment (without fertilizer), making the total number of treatments 16. The experimental plot was laid down in randomized complete block design with thee replications. All phosphorus was applied at transplanting while nitrogen was applied in two splits ½ at transplanting and the other ½ at early stage of flowering. The seedlings of pepper (Mareko Fana) were raised at Woramit testing site 50 days prior to transplanting. The spacing during transplanting was 30 cm between plants, 70 cm between rows, 1 m between plots and 1.5 m between blocks. The plot size of the experiment was 2.8 m X 3 m ($8.4m^2$) and the net plot size was 4.5 m^2. Water was supplied every week by furrow irrigation system until saturated.

Composite soil samples for the determination of physicochemical properties of the experimental plots were collected prior to planting. Samples were air dried, ground, and passed through 2 mm sieve and prepared for the analysis of most soil chemical properties except total N which needs to pass through 0.5 mm size sieve. Cation exchange capacity (CEC) was determined by the 1M ammonium acetate (pH 7) method according to the percolation tube procedure (Van Reeuwijk, 1993). Total nitrogen and available phosphorus were determined using Kjeldahl (Jackson, 1958) and Olsen (Olsen et al., 1954) methods, respectively.

Plant height (cm) was recorded using five randomly selected plants in each plot starting from the soil surface to the tip of the plant. Maturity date was recorded when at least fifty percent of the plant is matured while stand count, fruit length and fruit diameter were recorded at harvest. Uniform, unblemished, shinnies, absence of surface defects due to disease and insects, firmed fruits with normal fruit size based on visual observation were considered as marketable fruit while the rest were unmarketable fruits. In Each plot, all marketable and unmarketable fruits were harvested three times during the growth period when fruits become firmed and measured using triple balance. The sums of marketable and unmarketable fruits were considered as total fruit yield.

Data were subjected to analysis of variance using SAS statistical package (SAS Institute, 2002) to assess treatment effects. Whenever significant treatment differences were detected, means were separated using DMRT at 5% probability. In order to identify economically feasible recommendations partial budget analysis was done based on the manual developed by CIMMYT (1988). The partial budget analysis was based on data collected from Fogera district office of Trade and Transport, Cooperatives and from hot pepper farmers' field. At Fogera, the mean price of hot pepper, urea and DAP were 7.00 ETB kg^{-1} in the first scenario and 3.5 ETB kg ha^{-1} in the second scenario, 11.88 ETB kg^{-1} and 14.64 ETB kg^{-1} respectively. For sensitivity analysis, yields were adjusted downward by 10% from the exact yield while fertilizer cost was calculated by adding 10% ETB kg^{-1} increase from the current price of fertilizer. Minimum rate of return was taken at100%.

Results and Discussions

The result in 2011 indicated that there was statistically significant difference among the treatments in plant height, marketable yield and total yield (Table 2) but there was no significant difference in fruit length and fruit diameter (Table 2). The highest plant height was obtained from 46 kg N ha^{-1} and 20 kg P ha^{-1} followed by 69 kg N ha^{-1} and 30 kg P ha^{-1} (Table 2). But, there was no statistically significant difference among the other treatments in plant height (Table 2). During 2012, there was significant difference in fruit length, fruit diameter, plant height and yield among treatments (Table 3). The highest plant height was obtained from 138 kg N ha^{-1} and 20 kg P ha^{-1} followed by 92 kg N ha^{-1} and 30 kg P ha^{-1} and 138 kg N ha^{-1} and 40 kg P ha^{-1} (Table 3). The maximum fruit diameter was recorded at 115 kg N ha^{-1} and 20 kg P ha^{-1} (Table 3). In both years the maximum marketable (26460 kg ha^{-1} in 2011 and 27857 kg ha^{-1} in 2012) yield was obtained from 115 kg N and 20 kg P ha^{-1} (Table 3 and Table 4).

Table 2. Influence of N and P on hot pepper green pod at Rib irrigation scheme in 2011

Phosphorous P kg ha^{-1}	Nitrogen N kg ha^{-1}	Plant height cm^{-1}	Fruit length cm^{-1}	Fruit diameter cm^{-1}	Marketable Yield kg ha^{-1}	Total yield kg ha^{-1}
0	0	28.37ab	8.4367	1.28	17560f	17940f
20	46	32.67a	8.566	1.31	22360bc	22360b
20	69	30.57ab	8.2933	1.40	21890c	21890b
20	92	30.27ab	8.630	1.54	23447abc	24513ab
20	115	29.27ab	8.3933	1.46	26460a	26460a
20	138	27.20ab	8.770	1.62	23027abc	23463ab
30	46	31.53ab	9.196	1.45	24283abc	24283ab
30	69	32.07a	8.700	1.37	23600abc	23600ab
30	92	28.13ab	8.2167	1.52	23980abc	23980ab
30	115	25.47b	8.3367	1.57	25657ab	25657ab
30	138	28.83ab	8.510	1.57	23283abc	23283ab
40	46	29.77ab	8.760	1.49	22537bc	22537b
40	69	31.17ab	8.483	1.49	24717abc	24717ab
40	92	31.67a	8.210	1.60	22350bc	22350b
40	115	31.80a	8.573	1.44	23480abc	24230ab
40	138	27.33ab	8.190	1.53	23697abc	23697ab
CV(%)		12.35	7.77	13.21	7.25	8.21
Probability ($P<0.05$)		*	NS	NS	*	*

Table 3. Response of hot pepper to nitrogen and phosphorous at Rib irrigation scheme in 2012

Phosphorous P kg ha $^{-1}$	Nitrogen N kg ha $^{-1}$	Plant height (cm)	Fruit length (cm)	Fruit diameter (cm)	Marketable yield kg ha^{-1}	Total yield kg ha^{-1}
0	0	63.40^{h}	8.23^{c}	1.90^{e}	11984^{f}	12556^{e}
20	46	69.17^{fg}	10.10^{a}	2.50^{abcd}	17381de	18175^{bcd}
20	69	69.73^{defg}	8.33^{b}	2.49^{abcd}	16667de	17222^{cd}
20	92	73.53^{bcde}	9.63^{a}	2.53^{abc}	13412.70^{de}	14174.60^{d}
20	115	74.53^{abcd}	10.13^{a}	2.67^{a}	27857^{a}	27867^{a}
20	138	78.57^{a}	9.90^{a}	2.47^{abcd}	25119^{ab}	25129^{abc}
30	46	73.97^{abcde}	9.30^{ab}	2.37^{abcd}	18254^{bcde}	18929^{abcd}
30	69	71.70^{bcdef}	9.47^{ab}	2.23^{cd}	17619^{cde}	18071^{cd}
30	92	75.83^{ab}	9.20^{ab}	2.43^{abcd}	20714^{abcd}	21746^{abcd}
30	115	72.90^{bcdef}	9.07^{ab}	2.53^{abc}	17024de	17325^{cd}
30	138	73.17^{bcdef}	8.37^{b}	2.37^{abcd}	24841^{abc}	25421^{abc}
40	46	68.33^{fg}	9.63^{a}	2.17^{de}	15952de	16190^{cd}
40	69	66.20^{g}	9.37^{ab}	2.43^{abcd}	18095^{bcde}	18571^{abcd}
40	92	70.80^{cdefg}	9.10^{ab}	2.47^{abcd}	17619^{cde}	18135^{cd}
40	115	71.93^{bcdef}	9.10^{ab}	2.30^{bcd}	19524^{bcd}	27690^{ab}
40	138	75.67^{abc}	10.10^{a}	2.63^{ab}	20159^{bcd}	20476^{abcd}
CV (%)		4.12	7.59	8.44	22.72	28.20
Probability (P<0.05)		*	*	*	**	**

To observe whether there was significant difference among the treatments with the absence of the control treatment, separate analysis was done for the other treatments in the absence of the control and significant difference was observed among treatments (Table 4). The combined analysis over years also revealed that there was significant difference in marketable and total yield with the highest from 115 kg N and 20 kg P ha^{-1} even though maximum fruit length and fruit diameter were recorded from 115 kg N and 40 kg P ha^{-1} (Table 4).

Table 4. Combined analysis over years at Rib irrigation scheme for 2011 and 2012.

Phosphorous P kg ha $^{-1}$	Nitrogen N kg ha $^{-1}$	Plant height (cm)	Fruit length (cm)	Fruit diameter (cm)	Marketable yield kg ha $^{-1}$	Total yield kg ha $^{-1}$
20	46	50.92	9.42[abc]	1.86b[cd]	21353[abcd]	21761[abcd]
20	69	50.15	9.44[abc]	1.80[cd]	19277[de]	19678[de]
20	92	51.900	9.72[ab]	2.07[abc]	18737[e]	18652[e]
20	115	51.90	9.97[ab]	2.087[ab]	22769[a]	23138[a]
20	138	52.88	9.63[abc]	1.92[abcd]	20361[abcde]	20508[cde]
30	46	51.62	9.82[ab]	1.88[abcd]	22129[ab]	22550[ab]
30	69	53.01	9.61[abc]	1.80[cd]	21614[abcd]	21923[abcd]
30	92	51.98	9.70[abc]	1.89[abcd]	22136[ab]	22810[ab]
30	115	49.18	9.02[bc]	1.95[abcd]	21780[abc]	22839[ab]
30	138	51.00	8.75[c]	1.93[abcd]	21847[abc]	22260[ab]
40	46	49.05	9.79[ab]	1.72[d]	21869[abc]	19768[cde]
40	69	48.68	9.42[abc]	1.94[abcd]	19510[cde]	22306[ab]
40	92	51.23	9.76[ab]	1.90[abcd]	21735[abc]	22080[abcd]
40	115	51.87	10.11[a]	2.16[a]	22536[ab]	23421[a]
40	138	51.50	9.60[abc]	1.95[abcd]	21928[ab]	22174[abc]
CV		11.57	8.82	12.69	9.78	9.75
Probability		NS	*	*	**	**

Different studies showed that pepper responded to different rates of nitrogen and phosphorus. Amare *et al*. (2013), reported that 60 kg P ha^{-1} with 92 kg N ha^{-1} gave (10920 kg ha^{-1}) fresh marketable fruit yield at Bure. Similarly EARO (2004) gave blanket recommendation (200 kg P_2O_5 ha^{-1} and 100 kg N ha^{-1} (EARO, 2004) for hot pepper. Similar to the present study, Khan *et al*. (2010) recommended 150 kg N ha^{-1}) and 30 kg P ha^{-1} for Bangiladish. Phosphorus recommendations given by different authors at different place are higher than this finding; this may be due to the fact that the soil of the study site (Rib) has high available P. The recommendation for nitrogen was in conformity with the above findings. The high nitrogen demand by hot pepper in Rib irrigation area may be due to the low total nitrogen content of the soil (Table 1). Application of P fertilizer more than 20 kg ha^{-1} for hot pepper is unnecessary investment on P fertilizer. Similar trend was observed on total fruit yield in both years. However, the lowest marketable and total yields were obtained from the negative control (without fertilizer.)

The partial budget analysis showed that applying 115 kg N ha^{-1} with 20 kg P ha^{-1} had the highest net benefit (67753.22ETB ha^{-1}) and MRR of 2011.46 % followed by 46 kg N ha^{-1} with 30 kg ha^{-1} P gaining net benefit of 67019.65ETB ha^{-1} and MRR of 389.31% (Table 5). For one kg nitrogen and P fertilizer investment the farmer can get 20.11 ETB by using 115 kg ha^{-1} N with 20 kg ha^{-1} P fertilizers. In addition, application of 115 kg ha^{-1} N with 20 kg ha^{-1} P fertilizer gave 50.7% and 132.5 % yield advantage over the control in 2011 and 2012 respectively and application of these rates will boost the yield of hot pepper and increase the income of the farmers.

Table 5. Partial budget analysis using mean price of green hot pepper at 3.5 ETB kg^{-1}

P kg ha^{-1}	N kg ha^{-1}	Green hot pepper marketable yield per kg	adjusted green hot pepper	Total variable cost	Gross benefit	Net benefit	Marginal benefit	Marginal cost	MRR%
0	0	17557.32	15801.59	0.00	55305.56	55305.56			
20	46	21353.00	19217.70	2187.13	67261.95	65074.82	9769.26	2187.13	446.67
30	46	22129.00	19916.10	2686.70	69706.35	67019.65	1944.83	499.57	389.31
20	69	19277.00	17349.30	2781.13	60722.55	57941.42	D	94.43	
40	46	21869.00	19682.10	3186.26	68887.35	65701.09	7759.67	405.13	1915.35
30	69	21614.00	19452.60	3280.70	68084.10	64803.40	D	94.43	
20	92	18737.00	16863.30	3375.13	59021.55	55646.42	D	94.43	
40	69	19510.00	17559.00	3780.26	61456.50	57676.24	2029.82	405.13	501.03
30	92	22136.00	19922.40	3874.70	69728.40	65853.70	8177.47	94.43	8659.38
20	115	22769.00	20492.10	3969.13	71722.35	67753.22	1899.52	94.43	2011.46
40	92	21735.00	19561.50	4374.26	68465.25	64090.99	D	405.13	
30	115	21780.00	19602.00	4468.70	68607.00	64138.30	47.32	94.43	50.10
20	138	20361.00	18324.90	4563.13	64137.15	59574.02	D	94.43	
40	115	22536.00	20282.40	4968.26	70988.40	66020.14	6446.12	405.13	1591.12
30	138	21847.00	19662.30	5062.70	68818.05	63755.35	D	94.43	
40	138	21928.00	19735.20	5562.26	69073.20	63510.94	D	499.57	

D= Dominated, ETB= Ethiopian Birr

The sensitivity analysis indicated (Table 6) that under predicted worst economic condition 115 kg N ha^{-1} and 20 kg P ha^{-1} had the highest net benefit (67356.28ETB ha^{-1}) with MRR of 1813.26 %. Therefore, 115/20 kg N/P ha^{-1} is a valid fertilizer rate even under the worst price inflations that can be taken as economical fertilizer rates for green hot pepper production at Rib under irrigation (Table 6).

Table 6. Sensitivity analysis for the effect of nitrogen and phosphorus on the yield of green pod of hot pepper at Rib irrigation scheme.

P kg ha^{-1}	N kg ha^{-1}	Green hot pepper marketable yield kg ha^{-1}	10 % dawn ward adjusted green hot pepper kg ha^{-1}	Total variable cost	Gross benefit	Net benefit	Marginal benefit	Marginal cost	MRR%
0	0	17557	15801.5873	0	55305.5556	55305.56			
20	46	21353	19217.7	2405.56	67261.95	64856.38	9550.83	2405.57	397.03
30	46	22129	19916.1	2954.85	69706.35	66751.50	1895.12	549.28	345.01
20	69	19277	17349.3	3059.07	60722.55	57663.48	D	104.22	
40	46	21869	19682.1	3504.13	68887.35	65383.22	7719.73	445.07	1734.56
30	69	21614	19452.6	3608.35	68084.1	64475.75	D	104.22	
20	92	18737	16863.3	3712.57	59021.55	55308.99	D	104.22	
40	69	19510	17559	4157.63	61456.5	57298.87	1989.89	445.07	447.10
30	92	22136	19922.4	4261.85	69728.4	65466.55	8167.68	104.22	7837.16
20	115	22769	20492.1	4366.07	71722.35	67356.28	1889.73	104.22	1813.26
40	92	21735	19561.5	4811.13	68465.25	63654.12	D	445.07	
30	115	21780	19602	4915.35	68607	63691.65	37.53	104.22	36.01
20	138	20361	18324.9	5019.57	64137.15	59117.58	D	104.22	
40	115	22536	20282.4	5464.63	70988.4	65523.77	6406.18	445.07	1439.38
30	138	21847	19662.3	5568.85	68818.05	63249.20	D	104.22	
40	138	21928	19735.2	6118.13	69073.2	62955.07	D	549.28	

D = Dominated, ETB= Ethiopian Birr

Conclusion and recommendation

From the two years field experiment it is possible to conclude that nitrogen and phosphorus fertilizers are important to increase hot pepper yield. However, the amount of phosphorus required was low as compared to nitrogen due to the fluvial nature of the soil. This experiment was conducted on farmers field which was very difficult for water management that can be expressed in somehow its irregularity of the data in the two years. Even though it was very difficult to conduct such experiment on farmers' field, maximum effort was exerted to control variations due to management. Based on the partial budget analysis and biological yield results, it is possible to recommend 115 kg N with 20 kg P ha^{-1} as the first economically feasible fertilizer rate and 46 kg N with 30 kg P ha^{-1} as a second economically feasible fertilizer rate. Therefore, application of 115 kg N ha^{-1} and 20 kg P ha^{-1} followed by 46 kg N ha^{-1} and 30 kg P ha^{-1} for Rib and similar agro-ecologies under irrigation is feasible for hot pepper production.

Future fertilizer recommendation for Rib command area needs to be fine-tuned based on soil test and crop response based studies when the irrigation scheme construction is finalized in well organized irrigation research sites.

Acknowledgement

The authors are grateful to Ethio Nile Irrigation and Drainage Project (ENIDP) for the financial support, ARARI and Adet Agricultural Research Center for the facilitation and guidance for the successful accomplishment of the research.

References

Abbott T .S. (Eds.). 1989. BCRI soil testing methods and interpretation. NSW Agriculture and Fisheries, Rydalmere, NSW.

Aldana M. E. 2005. Effect of Phosphorus and Potassium Fertility on Fruit Quality and Growth of Tabasco Pepper (Capsicum frutescens) in Hydroponic Culture (MSc Thesis), Louisiana State University

Amare Tesfaw, Nigussie Dechassa and Kebede W/Tsadik. 2013. Performance of hot pepper (Cupsicum annuum) varieties as influenced by nitrogen and phosphorus fertilizers at Bure, Upper Watershed of the Blue Nile in Northwestern Ethiopia;International journal of Agricultural Sceinces ISSN:2167-0447 vol. 3(8), pp 599-608, October 2013 available online at www international scholars.org @ international scholars journal.

Bruce, R. C. and Rayment G. E. 1982. Analytical methods and interpretations used by the Agricultural Chemistry Branch for Soil and Land Use Surveys. Queensland Department of Primary Industries. Bulletin QB8 (2004), Indooroopilly, Queensland

Buyinza, M. and Mugagga F. 2010. Economic Viability of Hot Pepper (Capsicum frutescens L.) Cultivation in Agroforestry Farming System in Kamuli District, Uganda, J. Innov. Dev. Strategy 4(1):12-17 (August 2010)

CIMMYT (International Maize and Wheat Improvement Center). 1988. From agronomic data to farmers' recommendations: An economic work book, Mexico, D.F. CIMMYT.38-60p.

FAO (Food and Agricultural Organization). 2004. Hot Peeper Seed and Crop Production in the Bahamas, Available on: http://www.fao.org/docrep/007/y5259e/y5259e00.htm, Date accessed: 5 Oct. 2012.

Jackson M. L. 1958. Soil Chemical Analysis. Prentice Hall, Inc., Engle Wood Cliffs. New Jersey. pp.183-204.

Hochmuth, G. and Hanlon E. 2010. A Summary of N, P, and K Research with Pepper in Florida, University of Florida IFAS Extension, SL 334.

Khan, M.S.I., Roy S.S. and Pall K. K. 2010. Nitrogen and Phosphorus Efficiency on the Growth and Yield Attributes of Capsicum; Academic Journal of Plant Sciences 3 (2): 71-78

Pam Hazelton and Brian Murphy. 2007. Interpreting Soil Test Results; What Do All the Numbers Mean? University of Technology, Sydney (UTS), Department of Infrastructure, and Natural Resources & Planning: CSIRO PUBLISHING pages 66-83

Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean L. A. 1954. Estimation of available P in soils by extraction with sodium bicarbonate. USDA circular 939. pp.1-19.

S.A.S. (Statistical Analysis System), 2002. Guide for personal computers. 6th edn. S.A.S. Institute Inc., Cary, NC, USA

Seleshi Delelegn. 2011. Evaluation of Elite Hot Pepper Varieties (Capsicum species) for Growth, Dry Pod Yield and Quality under Jimma Condition, South West Ethiopia (M.Sc. Thesis), Jimma University, Ethiopia.

Van Reeuwijk. L.P.,1993. Procedures for soil analysis 4th edition. Technical paper 9, ISRIC, Wageningen.

Zhang, T.Q., C.S. Tan, J. Warner, C.F. Drury, A. Hamill, W. Reynolds, 2002. Agronomic and Environmental Consequences of Applying Fertilizer Nitrogen and Phosphorus to processing *Tomatoes and Green Peppers under Drip Fertigation*, Agriculture and Agri-Food Canada, Ontario, Canada.