EFFECTS OF CHEMICAL FERTILIZERS, MANURES AND LIME ON THE YIELD OF SUMMER TOMATO IN OLD PIEDMONT PLAIN SOIL

A THESIS

BY

MD. SOHEL RANA

Student No.1005065

Session: 2010-2011

Thesis Semester: September- March, 2011

MASTER OF SCIENCE (M.S.)

IN

SOIL SCIENCE

DEPARTMENT OF SOIL SCIENCE

HAJEE MOHAMMAD DAESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

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UNIVERSITY, DINAJPUR

March, 2012

DEDICATED

TO

MY BELOVED PARENTS

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The Author

Abstract

An experiment was conducted at the experimental field of Soil Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur during March to June, 2011 to evaluate the effect of manures, fertilizers and lime application on summer tomato. The experiment comprised five treatments- T_1 (cowdung), T_2 (chemical fertilizer), T_3 (lime), T_4 (poultry manure) and T_5 (control). Application of chemical fertilizer @ 550 kg N/ha, 450 kg P /ha and 250kg K/ha produced the highest yield (35.9 t/ha) of tomato. Between the manures used, the highest yield highest yield (23.35 t/ha) was obtained with the application of 1t /ha poultry manure. Nutrient content in the plant varied remarkably with different treatments. The NPK content of the plant was the maximum with application of chemical fertilizer and the Ca content went to the peak due to the cowdung treatment. Soil analysis result indicates that the NPK content was the maximum when soil was treated with chemical fertilizer.

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LIST OF ABBREVIATIONS

AEZ : Agro Ecological zone
Agric. : Agriculture
HSTU : Hajee Mohammad Danesh Science and Technology University
DAT : Days After Transplanting
RCBD : Randomized Complete Block Design

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CHAPTER I

INTRODUCTION

Tomato *(Lycopersicon esculentum* Mill.) is one of the most widely grown important nutritious vegetables in the world, belonging to the family Solanaceae. It was originated in tropical America (Salunkhe *et al.,* 1987) particularly in Peru, Ecuador and Bolivia of the Andes (Kalloo, 1986). Tomato is cultivated all over the country due to its adaptability to wide range of soil and climate (Hoque *et al.* 1999). Its food value is very rich because of higher contents of vitamins A, B and C including calcium and carotene (Bose and Som, 1990).

Tomato has a great demand throughout the year in Bangladesh. But in our country it is generally grown in the winter season. Although tomato plants can grow under a wide range of climatic conditions, they are extremely sensitive to hot and wet growing conditions, the weather which prevails in the summer to rainy season in Bangladesh. But limited efforts have been given so far to overcome the high temperature barrier preventing fruit set in summer-rainy (hot-humid) season. Its demand for both domestic and foreign markets has increased manifold due to its excellent nutritional and processing qualities (Hossain et. al, 1999). But it has great potentiality to grow in summer also. Due to its palatability and vitamin content its demand in general is growing day by day through out the year, while its production is far from the requirements especially in summer season. In summer availability of vegetable is less due to agro-ecological constraints. Cultivation of summer vegetables is affected due to excessive rainfall, wind storm, etc. during the monsoon season. Therefore, special thrust is needed to increase summer vegetables production and thereby also increase cash flow to the farm family. Production of summer tomato is highly remunerative and need-oriented.

Recent statistics shows that the cultivated area under tomato in Bangladesh was 23,818 hectares with a total production of 1,90,213 metric tons having an average yield of 7.98 t/ha (BBS, 2010). The low yield of tomato in Bangladesh, however, is not an indication of the low yield potential of this crop. The maintenance of soil fertility through manure and fertilizer management practices may improve the present situation. Ali and Gupta (1978) reported that NPK fertilizers significantly increased the yield of tomato. Similar results were reported by Laricheva and Demkin (1980) and Ahamed and Saha (1986).

Indiscriminate use of nitrogenous, phosphatic and potassic fertilizer is believed to cause deterioration of soil fertility, microbial activity, quality of ground water and finally decreases crop yield. On the other hand, the use of proper amount of NPK and well decomposed cowdung, poultry manure and lime improves texture, structure, humus, color, aeration, water holding capacity and microbial activity of soil. A good soil has an organic matter content of more than 3%. But in our country, the soils content less than 1.5%, some soils even have less than 1% organic matter (BARC, 1997). In Bangladesh, the productivity of soil is declining due to depletion of organic matter resulted by high cropping intensity. Nitrogen has the largest effect on yield and quality of tomato (Xin *et al.,* 1997). It also promotes vegetative growth, flowering and fruit set of tomato (Bose and Som, 1990). Phosphorus has pronounced effect on the number of flowers that progressively increases the yield (Razia and Islam, 1980; Al-Afifi *et al.* 1993; Candilo, 1993). Potassium application increases the flower number, peduncle leng'th, fruit set and number of fruits (Besford and Mann, 1975). Proper fertilizer management practices along with well decomposed cowdung, poultry manure and lime may improve this situation greatly.

Our farmers are habituated to use nitrogenous, phosphatic and potassic fertilizers than organic manure. On the other hand, organic manure is not always easily available. Moreover, the farmers are not fully aware about the importance of use of well decomposed cowdung. In Bangladesh, the application of both chemical fertilizers and well decomposed manure need to be encouraged.

Research on the effect of application of chemical fertilizers and cowdung, poultry manure and lime on the growth and yield of summer tomato is limited. Considering the above facts in mind, the present research was undertaken to obtain the following objective in northern part of our country.

Objectives of the study:

- to evaluate the effect of chemical fertilizer (N, P and K) on the yield of summer tomato and soil health.
- to investigate the effect of organic fertilizer (cowdung, poultry manure) on the yield of summer tomato and soil health.

Chapter II

REVIEW OF LITERATURE

The responses of summer tomato at nitrogen, phosphorus, potassium fertilizers, cowdung have been investigated by numerous investigators in various parts of the world. In Bangladesh, little work(s) have been done in this respect. However, the available research findings and information in this connection over the world have been reviewed in this chapter in the paragraphs with the hope that this may contribute useful information to the present study.

2.1 Effect of nitrogen on the growth and yield of tomato

Gonzalez *et al.* (2006) conducted to determine the effect of nitrate concentration in fertilizer solution on fruit quality, plant growth, and mineral content in shoots and roots of two tomato cultivars grown in peat moss. N concentrations of 34, 79, 124, and 169 mg/litre (corresponding to NO; concentrations of 150, 350, 550, 750 mg/litre) were evaluated in terms of plant response. Fruit yield, fresh weight, and dry matter of leaves, stems, roots and fruits were determined. Also the mineral and carbohydrate content in fruit tissues was determined. The results indicated that highest fruit production occurred at 79 mg N/litre. No differences in fruit production were found at 124 and 169 mg N/litre. The highest shoot and fruit fresh weight and dry matter were obtained with 79 mg N/litre.

Araki *et al.* (2005) estimated the growth and yield of tomatoes which were planted in a no-tilled field with hairy vetch *(Yicza villosa)* mulch (NT+HV) with 80, 160 and 240 kg/ha of nitrogen fertilizer, and compared with tomatoes grown in a tilled field with black polyethylene film mulch (TiII+BP).The tomato yield in NT+HV was lower than that of Ti11+BP in the first and second fruit cluster in 80 kg/ha of nitrogen, but was higher from tile 3rd to the 7th cluster. No definite effect of nitrogen fertilizer in the yield was recognized among 80, 160 and 240 kg in NT+HV. In 80 kg/ha of nitrogen fertilizer application, the total marketable yield of NT+HV was higher than that of Ti11+BP. There was no difference in total yield between NT+HV and Til1+BP in 160 and 240 kg/ha. In no-tilled field with hairy vetch mulch, even if nitrogen fertilizer is decreased to 80 kg/ha, the recommended level for N reduced tornato production, the marketable yield will be the same level obtained in conventional production with 160 and 240 kg/ha of nitrogen.

Tang *et al.* (2004) used a nitrate quick-testing technique for real-time control of nitrogen (N) topdressing in greenhouse tomato cultivation in the autumn-winter season in Shouguang, Shandong province, China. Sufficient organic manure was applied before planting and local farmers' conventional N topdressing was used as the control. Nitrogen topdressing rate recommendation was made based on the results of detennination of nitrate at the 0-5, 5-30, and 30-60 cm soil layers and of the petiole sap of the fully expanded leaves of the plants. As compared with the farmers' practice, tile amount of top-dressed N was reduced by 170 kg/ha in the real-time control treatment without any negative effect on shoot height, stem thickness, fruit development rate, marketable yield and quality parameters of tomato. The recommended target maximum N supply was 296, 216 and 191 kg/ha for the fruit expanding stages of the first, second, and fourth Cluster, respectively.

Prasad *et al.* (2002) conducted a field experiment during September 2000 to February 2001, in Allahabad, Uttar Pradesh, India, to study the effect of biofertilizers (vesicular arbuscular mycorrhiza (VAM) and *Azosparillujn sp.)* alone or in combination with various chemical fertilizers (N) on the growth, yield and quality of tomato *(Lycopersicon esculentuna* cv. Ches/KP/89-1). Combination of VAM and *Azospirillurii* was superior over the single application of VAM or *Azospirillulr7.* Mixed biofertilizer (VAM + *Azospiri!lurn)* with reduced 75% of recommended chemical fertilizer dose was found to be superior over all levels of biofertilizer and chemical fertilizer for growth and yield of this crop.

Haltlgl *et al.* (2000) conducted a number of experiments to investigate the influence of different N rates applied through drip irrigation on the growth and N uptake by tomato, pepper, Cucumber, melon and aubergine under greenhouse conditions. It was found that, for tomato, the % NUE was significantly increased by applying the N fertilizer through fertization (53.9%) as compared to the soil application (34.0%) at 100 mg N/litre. In general, any further increase of N fertilizer did not have an improving effect on the tomato yield. With pepper, the %NUE was significantly increased by applying the N fertilizer in the irrigation water (49.2%) as compared to the soil application (33.9%) at the same N level (140 mg N/litre), being the optimum N rate under our greenhouse conditions. At a fertilizer application level of 100 ing N/litre with fertization, the %NUE was significantly increased as compared to the soil application. With respectively Cucumber, melon and aubergine the %NUE with fertization was 63.4, 21.4 and 50.8%, while with soil application it was 34.0 11.0 and 18.8%. Nitrogen enhances the growth and development which ultimately increases the yield. While conducting an experiment in a solar green house with the aid of a computer, Xin (1997) established the relationship between N, P, K and effects on the yield and quality of tomato. Nitrogen had the largest effect on yield and quality, while the interaction between N and K was the most significant. The results showed those rates of N, P, K influenced tomato quality.

2.2 Effect of phosphorus on the growth and yield of tomato

Naem *et al.* (2006) studied the effects of phosphorous fertilizer treatments on the performance of tomato (cv. Super strain B) in Minia, Egypt, during 2004 and 2005.The treatments consisted of the inoculation of biofertilizers phosphorein and microbein, singly or in combination P (recommended rate) or P with the inoculation of phosphorein or microbein, or both. All treatments significantly enhanced the vegetative growth parameters (fresh and dry weights, plant height, and number of branches), fruit weight, and fruit yield. The greatest increases in most of the aforementioned parameters were obtained with the application P + Microbein. The levels of fruit total phenolic compounds were highest with Phosphorein + Microbein singly or in combination with the recomended P rates, the inoculation of Microbein together with the application P for tomato production.

Rideout (2004) found that the float system is an efficient method of seedling production. This systein requires the use of cultural practices to prevent excessive stem elongation of tomato seedlings. It is not known how these practices affect field growth and subsequent fruit yield and quality. Experiments were conducted in North Carolina, USA, during 2002 and 2003 to determine if restricting P supply, delaying fertilizer application, brushing, clipping, and ethephon application affect field performance of transplants. Transplants subjected to these cultural treatments in the float system were compared to transplants conventionally grown in the greenhouse. In 2002, there was little difference in field performance among transplants produced under the range of cultural conditions. Although differences in total fruit numbers or yields were non significant in 2003, conventionally grown transplants produced higher early yields. Seedlings grown with low P fertilizer and receiving delayed fertilizer application or delayed fertilizer application plus brushing performed the best float treatments in 2002.

2.3 Effect of potassium on the growth and yield of tomato

Bose *et al.* (2006) studied about the improved yield and yield attributes in tomato, as well as post-harvest quality, particularly at higher K rates. Field experiment was conducted in the sub-humid lateritic belt of West Bengal, India, to compare the growth, yield and yield attribute responses of tomato cv. S-120 treatments relying solely on KCI vs. a combination of $KCl+K_2SO_4.2MgSO_4$. In the crop use of potassium magnesium sulfate (K_2S0_4:ZMIg504; in conjunction with potassium chloride (hC11 pruvej superior to using KCI alone. -

Yan *et al.* (2004) found that Tomato *(Lycopersicon esculentum)* response to potassium (K) fertilizaticn on a well- drained central Iowa loam soil testing low in exchangeable K was evaluated over a 3-year period. Each year the experimental design was a factorial, split-p1ot randomized complete block with K rate as the whole unit (0 to 332 lb/ acre). The subunit was cultivar, either Mountain Spring' (determinate growth habit) or ' Jet Star' (indeterminate growth habit). Fruit harvest began the first week of *August* and continued weekly for 5 to 8 weeks. *For all* years there was a significant K rate and cultivar effect for all parameters, but no interaction except for marketable fruit size and unmarketable fruit produced. Increasing the K rate to 103 kg/ha increased fruit size of both cultivars to a maximum of 8.9 kg, but year accounted for greater fruit size differences than the choice of cultivar. Maximum marketable yield for both cultivars occurred at 220kg/ha K with 'Jet Star' producing 13% more fruit than ' Mountain Spring', 359 vs. 319 kg/ha, respectively. Cullage was high, mostly as a result of blotchy ripening disorders, with 'Jet Star' consistently producing more culls than 'Mountain Spring'. Increasing K rate did not reduce the percentage of culls, which remained constant at about 29% of total yield.

Idowu *et al.* (2002) studied in soil culture and found that the role of sodium (Na) in combination with potassium (K) on the growth and yield of tomato *(Lycopersicon esculentum)*. Na was applied at 0, 5, 10, 20 ing/kg soil as NaCl and K at 0, 20, 40, 80 mg/kg soil as KCl. Records of components of growth and mineral nutrient uptake and accumulation in plant tissue were taken. Na application at levels above 10 mg/kb improved number of leaves and root dry matter yields, while number of flowers and shoot dry matter yields were depressed. The application of K to varying levels of Na reversed the antagonistic effects of Na on plant growth. However, Na applied at levels lower than 10 mg/kg increased tissue N, P and Ca and decreased Mg and Na. A complimentary relationship between Na and K at a ratio of 1:8 or 1:16 was observed to have enhanced the growth and yield of tomato.

2.4 Effect of cowdung on the growth and yield of summer tomato

Grimme *et al.* (2006) conducted a field trail taking well decomposed cowdung along with vermicompost at a range of different concentrations into a soil-less commercial bedding plant container medium, Metro-Mix 360 (NIM360), to evaluate their effects on the growth and yields of tomato in the greenhouse. Four-week-old tomato *(Lycopersicon eseulenturta)* were transplanted into 100%, 80%, 60%, 40%, 20% or 10% MM360 substituted with 0%, 10%, 20%, 40%, 60%, 80% and 100% well decomposed cowdung and vermicompost. All plants were watered three times weekly with 200 ppm Peter's Nutrient Solution from the time of transplanting up to 107 days.Tomato grown in potting mixtures containing 40% decomposed eowdumg along with vermicomposts and 60% MM360 yielded 45% more fruit weights and had 17% greater mean number of fruits than those grown in MM360 only. The mean heights, numbers of buds and numbers of flowers of tomatoes grown in potting mixtures containing 10-80% vermicompost although greater did not differ significantly from those of tomatoes grown in MM360. There were no positive correlations between the increases in tomato yields, and the amounts of mineral-N and microbial biomass-N in the potting mixtures, or the concentrations of nitrogen in the shoot tissues of tomatoes.

Sangwoo *et al.* (2004) conducted an experiment taking two cowdung based and two plant-residue-based organic amendments to a simple peat-based potting mix were tested over two years for their ability to improve seedling biomass, out-planting success and yield in an organic tomato production system. Uniform, high quality transplants are essential for good field establishment of tomato and field-grown flowers. The health and vigor of these transplants can affect the long-term growth and quality of the harvestable portions. Healthy, vigorous starts will be less susceptible' to insect and disease pressure and other stresses. Based upon these findings, excellent quality tomato transplants can be produced using either plant-based or cowdung based organic amendments.

Adediran *et al.* (2003) found that there is need to determine the efficacy of biological waste products in the production of Vegetable seedlings. Tomato seeds were sown in the growing media and seedlings were allowed to grow for one month after emergence. Seedling height and stem diameter, and plant fresh and dry matter were recorded. The results indicated that the germination of tomato generally increased with time and varied with treatments. The performance of the soil less media was in the order of Hygromix> cowdung. Ninety-five percent (95%) germination was obtained with Hygromix by die' first week. The composts on the average produced germination of 60% by three weeks. In the second experiment, each of the composts was added to complement Hygromix at a weight ratio (compost : Hygromix) of 0: 1, 1:3, 1: 1, 3:1 and 1: 0 in 200 mL plastic cups.

Ahammad *et al.* (1999) conducted an experiment in Gazipur, Bangladesh, during November 1996 to March 1997 to determine the tomato, cv Ratan on roof gardens. The pots were supplied with different organic residues i.e. cowdung, poultry manure, mustard oil cake and urea at 11 different treatment combinations. There were significant differences among the treatments with respect to vegetative growth, flowering and fruiting, fruit characteristics and yield of grafted tomato. The highest fruit yield per plant (4.41 kg) was obtained in the poultry manure treatment.

2.5 Effect of poultry manure

Bharam *et al.* (2004) conducted an experiment where green manure, farm yard manure (FYM) and rice husk ash were applied with 0 ,40, 120 and 160kg urea – N / ha to the field of rice crop and a maize crop followed, every year, for six years to study the mineralization potential of the soil in laboratory. The potential mineralizable nitrogen was 63.6 to 83.2(75.0) mg/ kg in FYM, 58.7 to 76.9 (68.4) mg/kg in green manure, 56.2 to 68.3 (63.3) mg/ kg in ash and 55.4 to 68.8 (62.1) mg/ kg in the control treatment. Finally they conducted that all the manures and urea- N levels increased nitrogen mineralization potential.

Lin- Yu Wen *et al.* (2003) investigated the nitrogen mineralization of nine commercial / farm – produced organic materials was investigated by incubation leaching method. The accumulative mineralized N (AMN) released was observed during 2, 4, 6 and 8 weeks incubation period. Nine materials were divided into two groups according to their mineralization characteristic curves of 8 weeks incubation.The continuous release of mineral N of Group 1 (hog manure 1, hog manure 11, chicken manure , sawdust compost and bagasse compost) started at the 1st week and reached the first AMN peak at the 1st or the 2nd week, and then was getting slow in the subsequent 1-5 weeks. All in group 2 (cattle manure, rice straw,sesbania and pure bagasse) presented N immobilization in the 8 week incubation, except for the 1st and 2nd day where N mineralization was observed in some material. Mineralization characteristic curve after the 8th week indicated AMN of hog manure 1 increased within 36 weeks , and the second AMN peak of chicken manure occurred at the 24th week.

Aulakh *et al.* (2000) investigated the C and N mineralization of cattle manure (C:N =14) and poultry manure (C:N= 12), in a growth chamber. Mineralization of cattle manure, poultry manure, and green manure nitrogen over 16 days was 12, 20 and 44% respectively, and was inversely related to C:N ratio, and directly to N content of organic manure.

Bath and Ramert (2000) evaluated composted and an aerobically digested organic household wastes as nitrogen sources and they found after 168 days of incubation the percentage of inorganic nitrogen of total N applied as 40-60 % for slurry, 15% for compost and 20-30% for chicken manure.

Trehan (2000) stated that an experiment was conducted over a period of one year to find gross and net mineralization of N from cattle slurry decomposing in soil at 25 degree C and 50percent water holding capacity moisture. Measurements were made at different intervals for NH_4-N, NO_3-N, organic- N, clay fixed- N and gross mineralization and immobilization of N. There was extensive mineralization and immobilization of N in a slurry-amended soil and there was no net mineralization of N over about 30 days because rates of both the reactions were equal. The amount of N mineralized from the organic fraction of slurry in one year was 49.1 percent of the organic N in slurry and net mineralization was 26.3 percent of the organic N in slurry.

Hartz (2000) stated that nitrogen and carbon mineralization rate of 19 manure and compost samples were determined in 1996. These organic amendments were mixed with a soil : sand blend at 2% by dry weight and the amended blends were incubated at constant moisture for 12(1996) or 24 weeks (1997) at 25 degree C. Net N mineralization was measured at 4-week (1996) or 8-week (1997) intervals. An average of 16%, 7%, and 1% of organic N was mineralized in 12 weeks of incubation in 1996, and an average of 15%, 6%, and 2% in 24 weeks of incubation in 1997, in manure, manure compost, and plat residue compost, respectively.

2.6 Effect of Lime on the production of summer tomato

Carbon and Nitrogen mineralization of organic manure

Animal manure has long been used as an organic source of plant nutrients and organic matter to improve the physical and fertility conditions of agricultural lands (Dao and Cavigelli, 2003). So it is important to study the nutrient release pattern, especially carbon and nitrogen. The quality of animal manure might be improved when rice straw and other organic material is mixed with animal manure rather than sole.

Aulakh *et al.* (2000) investigated the N and C mineralization of cattle manure (C:N=35) presmud (C:N= 22), green manure (C:N=14), poultry manure (C:N=12), in a growth chamber. The mineralization of N started quickly in all manures except presmud, where immobilization of soil mineral N observed for an initial 4 years. Mineralization of cattle manure, poultry manure, presmud and green manure nitrogen over 16 days was 12, 20, 29 and 44% respectively, and was inversely related to C:N ratio, and directly to N content of organic manure. The carbon mineralized over 16 days ranged from 6% to 50% in different manures added to soil under different moisture regimes and was in general inversely related to initial C:N ratio of manure.

Kraus et al. (2000) determined the N mineralization patterns of three composts under three temperature regimes (45, 25 and 45/25 degree C). More organic N was mineralized from composted turkey liter than from municipal or garden compost, regardless of temperature. The percentage of organic N mineralized from composted turkey liter was greater at 45/25 and 45 degree C than at 25 degree C.

Trinsoutrol *et al.* (2000) found that the apparent mineralization of residue carbon after 168 days varied from 330 to 670 g/ kg of added C. Mineralization kinetics were described using a compartment decomposition model that decomposes according to first order kinetics. Amount of carbon mineralized after 7 days and the decomposition rate coefficient of the liable fraction were related mainly to the soluble carbon from of the residues. No statistical relationship was established between the nitrogen concentration of residues and their decomposition in the soil. The mineral nitrogen dynamics were related mainly to the organic nitrogen concentration of the residues and to their C:N ratio.

Pare *et al.* (2000) reported that net carbon and nitrogen mineralization from a loam soil amended with non-treated poultry manure and treated poultry manure in an incubation study at 25 degree C. After 60 days of incubation 62 and 77% of total poultry manure nitrogen was mineralized in non-treated poultry manure and treated poultry manure amended soil, respectively.

Chadwick *et al.* (2000) found the readily mineralization nitrogen fraction (refluxing with KCI) was the largest in the pig farm yard manures and broiler litters, but on an average only represented 7-8% of the total N content. The greatest N mineralization was measured from layer manure and pig slurry. Lowest percent nitrogen mineralization was measured from a dairy cow- slurry (<2%) and a beef farm yard manure (6%). The mineralization rate was negatively related to the C : organic N ratio of ammonium N stripped manure.

Mishra *et al.* (2001) studied the decomposition of rice straw and described three phases in decomposition. The first phase lasted for 5 weeks in which the rate of decomposition was relatively faster, followed by the second phase of slow rate of decomposition from 6^{th} to 15^{th} week and then again a faster rate of decomposition in the third phase. There was practically no nitrogen mineralization from the rice straw during the first phase but there after N mineralization proceeded gradually. More than half of the N mineralization during the third phase of decomposition.

Hartez *et al.* (2000) investigated nitrogen and carbon mineralization rates of 19 manures and compost samples. The samples were incubated at constant moisture for 12 weeks at 25 degree C. An average of 16%, 7% and 1% of organic nitrogen was mineralized in 12 weeks of incubation in manure, manure compost and plant residue compost, respectively. Mineralization of manure carbon average 35% of initial carbon content in 24 weeks, while compost carbon mineralization average only 14% within 4 (compost) or 16 weeks (manure), the rate of mineralization of amendment carbon had declined to a level similar to that of soil organic carbon.

2.7 Combined effect of N, P, K and Cowdung on the growth and yield of tomato

Patil *et al. (2006)* studied the effects of inorganic and organic fertilizers on the fruit yield and quality of tornato (cv. *Parbhani Yashshri)* in Parbhani, Maharashtra, India, during rabi *2004/05.* The treatments consisted of 100% recommended fertilizer rate (RFR; *100:50:50* kg NPK/ha), *75%* RFR + *25%* Celrich, Teracare, farmyard manure (FYM) or well decomposed cowdung ; *50%* RFR + *50%* Celrich, Teracare, FYM or well decomposed + cowdung; *25%* RFR + *75%* Celrich, Teracare, FYM or well decomposed cowdung; and 100% organic fertilizer *(25%* each of FYM, Teracare, Celrich and well decomposed cowdung). Celrich (2.0 t/ha), Teracare *(2.5* t/ha), FYM *(25.0* t/ha) and well decomposed cowdung (25.0 t/ha) were applied at 10 days before transplanting. Plant height, number of primary branches, and number of leaves were evaluated from 30 to 105 days after transplanting. The application of *50%* RFR + *50%* FYM resulted in the greatest plant height *(120.70* cm), number of primary branches per plant (8.53), number of fruits per plant (52.0), average fruit weight *(45.06* g), yield per plant *(2.34* kg), and total soluble solid content *(6.08%).* The highest number of leaves per plant was obtained with 50% RFR + *50%* FYM (118.10) and 50% RFR + 50% well decomposed cowdung (116.63). Ascorbic acid content (26.76, 26.53 and 25.97 mg/100 g) and shelf life (6.91, 7.00 and 6.22 days) were highest with 50% RFR + 50% FYM, 50% RFR + 50% well decomposed cowdung and 100% organic fertilizers.

Yong *et al.* (2005) found that the nutrient requirement of fruit and vegetable, which met not only nutritional balanced demand for fruit and vegetable crop for high yield and growth, but also significantly increased yield, economic and quality. Results of field trials showed that well decomposed cowdung and general compound fertilizer under the N, P, K, the treatment with specific compound fertilizer increased by 10.81-20.28°ro for Litchi sp. and mango, 1.50-16.28% for watermelon and banana, 5.85-12.82% for pepper and tomato, respectively. Also, the quality of crops were improved such as sugar, protein and Vitamin C content.

Jurisic *et al.* (2005) conducted experiment to determine the effects of compost, well decomposed cowdung (KMlA and KM1B) and/or mineral fertilizers on tomato growth and yield. Treatments comprised: fertilizer rating 15:15:15 at 700 kg NPK/ha (T_I); fertilizer rating 15:15:15 at 350 kg NPK/ha and 2500 kg compost/ha (T_2), well decomposed cowdung; and compost, well decomposed cowdung alone at 5000 kg/ha (T_3). Among all treatments, tomato yield was highest with T_2 application, recording 62.3 t/ha, on average. Tomato yield in this treatment was higher by 14.83 t/ha (23.8%) than that of T_3. The dry matter share was highest in T;, recording 7.6% compared to T, (4.8%). T_z brought about the highest yield and suitable dry matter share (6.8%) compared to $T_{i.}$ Rosy red fractions had significantly highest fruit number per plot (520.11) compared to the other fractions. Although the plot fruits had, on average, the highest mass (15.66 kg) with $T_{2,}$ the differences were not statistically justified. The least fruit mass was recorded by T, (10.08 kg). The rosy red fraction had the largest fruit mass (even 31.53 kg). However, the green and unused fruits weighed 6.70-7.87 kg , per plot. The average fruit mass was highest, as most of investigated traits, with the application of T_z (118 g, higher by 5% compared to other treatments). The results indicate the positive effect of organomineral fertilizer application on the yield and some yield components.

Choudhury *et al.* (2004) conducted a field experiment in the Experimental Farm of the Assam Agricultural University in Assam, India, to study the effect of inorganic fertilizers coupled with well decomposed cowdung and bio-fertilizer on organic carbon, available N, P and K in soil as well as on plant growth parameters of tomato *(Lycopersicon esculentum).Tl1e* incorporation of Az, PSB, and well decomposed cowdung with inorganic fertilizers significantly improved the organic carbon content and available N, P and K status of the soil. The highest plant height, number of leaves per plant and yield of tomato were obtained with the Az, PSB, well decomposed cowdung and inorganic fertilizers, followed by PSB, well decomposed cowdung and inorganic fertilizer treated soils. The population of *Azotobacter* in the native soil was less than the PSB. Inoculated and fertilizer nitrogen added soil maintained increased microbial population.

Mello and Vitti (2002) carried out an experiment between February and August in 1997 to evaluate the effects of different organic wastes on the growth of tomato *(I,ycopersicon esculentum)* plants and on the chemical properties of an ultisol soil. Three organic wastes (rnalt) residues and eucalyptus chip compost, urban solid waste compost and cowdung and four mates equivalent to 0; 100; 150; and 200 kg/ha of N. The fruit yield did not increase and did not change the soil chemical properties.

Gizy *et al.* (2001) carried out two pot experiments during the early summer seasons of 1999 and 2000 on a calcareous soil in Giza, Egypt to investigate the effects of compost, well decomposed cowdung and different N sources on 2 tomato cultivars, Line 73 and Floradade. Each pot received 7 kg soil. Two rates of compost, well decomposed cowdung were used: i.e. 2.5 and 5.0% as pot media, in addition to the control treatment. The N fertilizer was added at 4 sources, i.e. nitric acid solution (0.1 N), nitric-calcium nitrate (1:1) mixture, calcium nitrate solution and urea solution on N content basis. All these sources were added at one rate (40 kg/ha), 35 mg N in each rate every 15 days (280 mg N/pot containing 7 kg soil with a total of 8 rates) compared with no mineral N application. The tomato cultivars differed significantly; Line 73 produced higher number of leaves, dry matter content as well as fruit yield than Floradade, which contained higher concentrations of macronutrients and micronutrients. Adding compost significantly increased number of leaves, fruit yield and nutrient uptake. The highest increments were achieved under the higher compost rate of 5%. N application was very important to tomato plants in such soil regardless of the form added. The completely and partially acidic N form induced a positive effect on the availability of nutrients such as P, K and micronutrients, which was reflected on the uptake by all organs. Floradade was more sensitive to soil acidification than Line 73. Adding compost to soil in the presence of acidic N form could be recommended for best results in terms of fruit yield and favorable nutrient uptake.

Pribetic *et al.* (2000) conducted an experiment to evaluate the response of tomato (cv. Professional Fl) plants to applied manures and fertilizer viz. 700 kg NPK, 15:15:15/ha; 350 kg NPK, 15:15:15/ha + 2500 kg compost/ha; or 5000 kg compost/ha in a field experiment conducted in Porec, Croatia in 1996. The physiochemical properties and yield of the fruit and crop respectively were investigated. The highest tomato yield was obtained by the application of cowdung and mineral fertilizer amounting 62.3 t/ha on the average, being higher by P=5% compared to the variant without compost.

2.8 Combined effect of organic and inorganic fertilizers

Organic manures are the main source of soil organic matter, which has a fundamental effect on the physical and physio-chemical properties of soil. Organic manures are also an important source of plant nutrients but contains relatively small amount, which are not readily available. On the other hand, inorganic fertilizer contains specific, higher and readily available plant nutrients. So the combination of organic manures and inorganic fertilizers must be more productive. A number of researchers studied the combined effect of organic manures and inorganic fertilizers. Some of these research information's are reviewed here.

Mello and Vitti (2002) carried out an experiment between February and August in 1997 to evaluate the effects of different organic wastes on the growth of tomato (L. esculentum) plants and on the chemical properties of an Ultisol soil. Three organic wastes (malt) residues and eucalyptus chip compost, urban solid waste compost and chicken litter and four mates equivalent to 0; 100; 150; and 200kg/ha of N. The fruit yield did not increase and did not change the soil chemical properties.

Nabi and Nandy.(2001) observed that plant height of summer tomato (BARI tomato-4) ranged from 84.21 cm to 110.30 cm and the lowest value was observed in the control and the highest in the treatment N250 P150 K150. Fruits length was higher in the treatments where balanced doses of fertilizers and generally higher doses of N were used.

Nakano *et al.* (2001) reported that Maize steep liquor , which was an organic product derived from maize starch factories, contained about 3% each of N, P_2O_5 and K_2O. Attempts were made to use maize steep liquor as a sole fertilizer for fertilization of tomato cultivation. The increase in the activity of the bacteria and soil enzymes led to the rapid decomposition and mineralization of maize steep liquor. The process involved in organic fertilization, which was effective in supplying sufficient amount of nutrients for tomato growth.

Youssef *et al.*(2001) carried out an experiment to study the effect of different fertilizers, i.e. mineral (ammonium nitrate and potassium sulphate) and organic manure (chicken manure) alone or in combination, on the quantity and quality of tomato cultivars Lydia and Orit under clear polyethylene low tunnels. Treatment with 100% organic manure alone or in combination with ammonium nitrate resulted in taller plants than other treatments. However, fruit dimensions were the highest with organic manure alone.

Green house pot experiment was conducted by Mandal et al.(2000), to determine the effect of N and S fertilizers on nutrient content of summer tomato cv. BARI-4 at BARI, Gazipur. Nitrogen was applied as urea @ 0, 50, 75 and 100 kg N /ha and sulphur was applied as gypsum @ 0, 5, 10 and 2 kg S /ha. Nitrogen applied alone did not affect the S content of tomato shoot but N and S fertilizer combinations increased straw S content only during the tillering stage.

Pribetic *et al.*(2000) conducted an experiment to evaluate the response to tomato (cv. Professional F1) plants to applied manures and fertilizer viz. 700 kg NPK, 15:15:5 /ha ; 350kg NPK, 15:15:15/ha + 2500 kg compost /ha; or 5000 kg compost /ha in a field experiment conducted in Porec, Croatia in 1996. The physiochemical properties and yield of the fruit and crop respectively were investigated. The highest tomato yield was obtained by the application of compost and mineral fertilizer amounting 62.3

t/ha on the average, being higher by P=5% compared to the variant without compost.

Stoffell and Graetz (2000) carried out an experiment on sugarcane filter cake (a waste byproduct of sugarcane processing) compost to evaluate the partial substitute for inorganic fertilizer in a fresh market tomato crop production system in a field experiment in Florida, USA. Plots receiving fertilization rates of 0, 50 or 100% (153 N-134 P-280 K, kg/ha) of a typical commercial application were amended with or without compost (188 t/ha). Tomato (cv. Sunny) seedlings were transplanted . It gave significant result of the tomato variety.

Nabi and Nandy.(2000) observed in a fertilizer trial on summer tomato (BARI tomato-4) that 250kg N, 150kg P and 150kg K per hectare along with 10 t/ha cowdung produced the highest yield (21.44 t /ha). Similar yield (21.21 t/ha) of summer tomato was obtained at the fertilizer rate 300-200-150 kg/ha.

2.9 Effect of organic manure

The organic matter is called the life of the soil. Fertility of a particular soil is determined by the presence of organic matter. The organic matter content of soil depends on several factors like origin of soil , climatic conditions, vegetation, microbial activitiesetc. The physical , chemical and biological properties of soil are greatly influenced by organic matter. Although, organic matter contains all the essential plant nutrients, but it requires time to release the nutrients in the available forms to the plan. That is why the response of crops to organic manures is low. But due to the residual and beneficial effects on soil properties, application of organic manures is encouraged. Some available information about the effects of organic manures on growth and yield of tomato are reviewed here.

Lin, ChunHua et al. (2000) reported that the effects of organic fertilizers and nutrient solutions on cherry tomato production in growing media were investigated . The results showed that the pure chicken manure decreased yield and the chicken manure mixed with inorganic compound fertilizer increased yield and income , but the chicken manure mixed with peanut-cake, chicken manure mixed with tea-seed-cake increased quality, yield and income, and decreased fertilizer costs compared with nutrient solution culture alone.

Ahammad *et al.*(1999) conducted an experiment in Gazipur, Bangladesh, during November 1996 to March 1997 to determine the growth and yield of tomato cv. Ratan on roof gardens. The pots were supplied with different organic residues i.e. cowdung, poultry manure, mustard oil cake and urea at 11 different treatment combinations.There were significant differences among the treatment with respect to vegetative growth, flowering and fruiting, fruit characteristics and yield of grafted tomato. The highest fruit yield per plant (4.4 kg) was obtained in the poultry manure treatment.

2.10 Effect of N, P, K:

Mitra (2000) reported that nitrogen applied as a top dressing was better utilized by the plants than as a basic dressing while phosphorus nutrition was found important during the entire growing season. He also reported that increasing the rates of N, P and K from 12, 12, 12 to 36, 36, 36 kg/ha, respectively increased the amount of nutrient uptake by tomato plants.

Ogbadu and Easmon (1999) reported that the highest concentration of phosphorus and potassium were found in tomato fruits treated with NPK fertilizers.

2.11 Effect of N, P fertilizers

Yadav and Batra (2001) found that nitrogen and phosphorus uptake showed an increasing trend with an increase in fertilizer level of nitrogen and phosphorus application in tomato.

2.12 Phosphorus mineralization

Eghball (2002) found that mineralization of organic N is expected to be low for composted manure (=18%) and high for swine or poultry (hens) manure (55%).

Phosphorus (P) availability from all animal production sources of manure is high (70%), as most of the manure P is inorganic and becomes plant –available after application.

Crous (2002) stated that a simultaneous study was conducted to measure the relative concentration of organic P forms during the mineralization process using P31 nuclear magnetic resonance. Subsamples from the poultry manure-amended soil were extracted with 0.25 M NaOH +0.05 M EDTA following 0, 1, 2, 3, 4, 8, 12, 16, and 20 weeks after manure addition and incorporation. The concentration of organic P compounds decreased from the time of poultry litter incorporation until week 20 whereas orthophosphate concentration increased during this period.

Khankhane and Yadav (2000) stated that an experiment was carried out in plastic containers with farm yard manure, biogas slurry and sewage sludge added in sandy clay loam soil @ 5, 10 and 15 t/ ha with and without N-P fertilizer. Moisture was maintained at field capacity level throughout the incubation period and samples were drawn at the 1, 2, 4, 8 and 16 weeks and analyzed for NH_4-N,NO_3-N+ NO_2-N , saloid-P, Al-P, Fe-P and Ca-P. Ammonium- N decreased and NO_3- +NO_2-N_increased significantly with increase_in incubation period from 1 to 16 weeks in all the organic manures. Highest NH_4-N was observed in sewage sludge followed by biogas slurry and farm yard manure. Higher rate (15t/ha) of all the manures mineralization significantly more NH_4+ and NO_3- +_NO_2-N fractions. Additio of urea and single superphosphate at 120 kg N and 60 kg P_2O_5 /ha enhanced the mineralization of both the NH_4-N and NO_3-N + NO_2-N contents. Among the inorganic phosphorus fractions , saloid- P decreased while Al-P, Fe-P and Ca-P increased significantly with increasing period of incubation.

2.13 Potassium Mineralization

Naher *et al.* (2004) an experiment was conducted in greenhouse to measure the P and K mineralization rate from fulvic acid with fresh poultry manure, and partially decomposed cowdung. Partially decomposed cowdung contain 127ppm of fulvic acid

P and 2.23 meg/100g of fulvic acid K whereas the poultry manure contain 378 ppm of fulvic acid P and 13.4 meq/100g of fulvic acid K. The lime addition increased P concentration in cowdung treatments and the highest of 1505 ppm of fulvic acid P was recorded at 75 days of decomposition in the covered cowdung + lime treatment. The addition of rice straw increased K concentration in both cowdung and poultry manure treatments but it decreased the mineralization rate. The highest of 67 meq/100 g of fulvic acid K was mineralized at 75 days of decomposition in the uncovered poultry manure + rice straw treatment. The fulvic acid P mineralization was higher in the covered cowdung and poultry manure treatments. The fulvic acid K mineralization was also high in the covered cowdung treatments but in the poultry manure treatments it was higher in the uncovered treatments.

Mishra *et al.*(2001) found that during decomposition of the rice straw, carbon and potassium content decreased , nitrogen and phosphorus content increased, and C:N ratio decreased with time. Potassium release was however initially fast and then slowed down where as phosphorus mineralization proceeded gradually. About 4.5% of the total N, 22.5% of the total P and 79% of the total K present in the rice straw were released within 6 weeks since its burial in the soil.

2.14 Environmental effect

Islam and Khan (2000) evaluated the seasonal fluctuation of physical and biochemical characteristics of tomato in Kagawa, Japan at seven different sowing times. They noted seasonal variations in the external and quality characteristics. Fruits ripened rapidly during summer followed by a progressive decline towards the winter season. The crop duration was shortened for summer harvesting and extended for winter to spring harvesting of the fruits.

Chapter III

MATERIALS AND METHODS

In this section the materials and methods have been presented which include brief description of location of the experimental site, soil, climate, materials used and methodology followed in the experiment. The details of these sections are described below.

3.1 Experimental site

The present research work dealing with the effect of N, P, K, cowdung, Poultry manure and lime on the growth and yield of summer tomato was carried out at the research field of Soil Science Department of Hajee Mohammad Danesh Science & Technology University, Dinajpur during the period from March to June 2011.

3.2 Climate

The climate of the study area is characterized by a heavy rainfall during kharif season (April to September) while a scanty rain fall during the rest period, i.e. during the Rabi season (October to March). The mean maximum temperature in the summer (March to September) was 35^0 C and the mean maximum temperature in the winter (November to March) 11.9^0C.

3.3 Soil

The experimental plot was a medium high land belonging to the Old Himalayan Piedmont Plain (AEZ 1). Land was well-drained and drainage system was well developed. The soil texture was sandy loam in nature. The soil pH was 5.56. The details soil properties are presented in Appendix-I.

3.4 Experimental materials

The summer tomato variety used in the experiments was "BARI – 4". This is a high yielding indeterminate type. The seeds of the variety were collected from the Dinajpur seed market. The variety was marketed by ACI seed Company Limited.

3.5 Raising of seedlings

Tomato seedlings were raised in a seed bed situated on a relatively high land adjacent to the research field of Crop Physiology & Ecology Department. The size of each seedbed was 3m x 1m. The seed bed was well prepared with spade and made into loose friable and dried mass to obtain fine tilth. All weeds and stubbles were removed and the soil was mixed with well rotten cowdung at the rate of 10 kg/bed. Miral 3 – GN was applied in each seedbed as precautionary measure against ants and cut worm. Five gram of seeds was sown in a seedbed on March 28, 2011. Sown seeds were covered with light soil. Complete germination of the seeds took place within 6 days after sowing. Necessary shading by polythene tunnel was provided over the seedbed to protect the young seedling from scorching sunshine or heavy rain. Weeding, mulching and irrigation were done from time to time as and when needed.

3.6 Experimental treatments

T_1= Cowdung

T_2= Chemical fertilizer (N, P, K)

T_3= Lime

T_4= Poultry manure

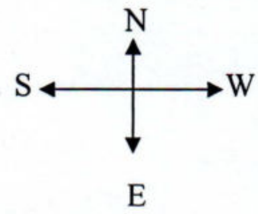
T_5= (Control)

In case of T_1, only cowdung were applied, chemical fertilizer were applied in T_2, lime and poultry manure were applied in T_3 and T_4, respectively. All the fertilizer and manures were applied as per the recommended doses of fertilizer recommended guide. While, in T_5 tomato was planted without application of fertilizer and manures i.e. control.

3.7 Design of experiment

The single factor experiment was laid out in the Randomized Complete Block Design(RCBD) with 3 replications. Each block consisted of five plots. The treatments were randomly distributed within the blocks. An individual plot was 3 m ×1.5 m, i.e. 4.5 m^2 in size. Distances of 1m and 50 cm were maintained between the blocks and plots, respectively.

The design of field experiment was as follows :



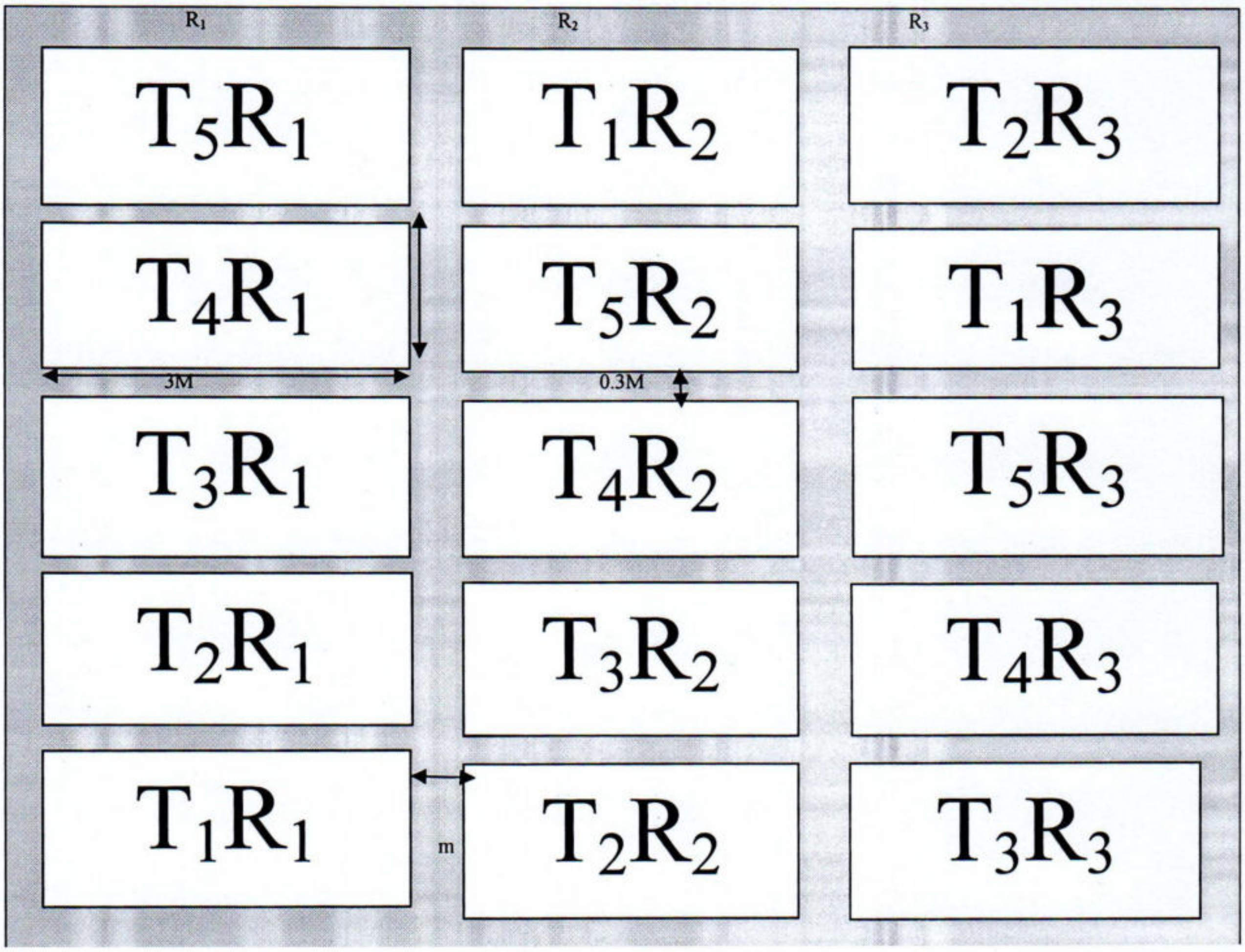


Figure 3.1. Layout of experimental field for Summer tomato cultivation

3.8 Cultivation of tomato

3.8.1 Land preparation

The selected land for the experiments was first opened on 18 April 2011 by disc plough. After discing the land was ploughed and cross ploughed six times by a power tilter to obtain good tilth. Each ploughing was followed by laddering to break up the soil clods into pieces and to level the soil surface. All weeds and stubbles were removed from the plots.

3.8.2 Manuring and fertilization

In the experiment nitrogen, phosphorus and potassium were applied as per treatment at the rate of 253, 92.88, 124.5 kg per hectare, respectively (BARI, 2005). Well decomposed cowdung was applied at the rate of 1000 Kg per hectare, well rotten poultry manure was also applied at the rate of 1000 Kg per hectare and lime also applied at the rate of 74.11 Kg per hectare, respectively. Full doses of chemical fertilizer, cowdung, poultry manure and lime was applied in each treatment as basal dose.

3.8.3 Transplanting of seedlings

Healthy and uniform 30 days aged seedlings were uprooted separately from the seedbed and were transplanted in the experimental plots in the afternoon of 26 April 2011 maintaining a spacing of 60 cm x 40 cm between the rows and plants respectively. The seedbed was watered before uprooting the seedlings from the seedbed so as to minimize damage to the roots. The seedlings were watered after transplanting. Shading was provided using banana leaf sheath for three days to protect the seedling from the hot sun and removed after seedlings were established. Seedlings were also planted around the border area of the experimental plots for gap filling.

3.8.4 Intercultural operations

After transplanting seedlings, different intercultural operations were accomplished for better growth and development of the plants.

3.8.4.1 Gap filling

When the seedlings were established, the soil around the base of each seedling was pulverized. A few gaps filling was done by healthy seedlings of the same stock previously planted in the border area on the same date of transplanting.

3.8.4.2 Weeding

Weeding was done as and whenever necessary to keep the crop free from weeds.

3.8.4.3 Staking and pruning practices

When the plants were well established, staking was given to each plant by Bamboo sticks to keep them erect. Within a few days of staking as the plants grew up, they were pruned uniformly upto 50 DAP leaving single main stem per plant.

3.8.4.4 Irrigation

Two irrigations were given through the growing period. The first irrigation was Given 30 days after planting followed by irrigation 20 days after the first irrigation.

3.8.5.1 Plant protection

Insect pests: As preventive measure against the insect pests like leaf minor and others, Sevin 85 SP was applied at the rate of 1-2g /litre water. The insecticide applications were done fortnightly as a routine work frorn a week after transplanting to a week before first harvesting.

3.8.5.2 Disease

During foggy weather precautionary measures against disease infestation especially 1 ate blight of tomato was taken by spraying Dithane M-45 fortnightly @ 2 g/L.

3.9 Harvesting

Fruits were harvested at 5 days intervals during maturing and ripening stage. The maturity of the crop was determined on the basis of red colouring of fruits. Harvesting was started from 20 June and was completed by 9 July 2011.

3.10 Collection of data

Three plants were selected randomly from each plot for data collection in such a way that the border effect could be avoided for the highest precision. Data on the following parameters were recorded from the sample plants during the course of experiment.

3.10.1 Plant height

Plant height at final harvest was measured from sample plants in centimetre frorn the ground level to the tip of the longest stem and mean value was calculated. Plant height was also recorded at 15 days interval starting after transplanting up to 65 days to observe the growth rate of plants. Lastly, the height was recorded at final harvest.

3.10.2 Days to first flowering

First flowering date was recorded at 3 May 2011.It was considered with the anthesis of flower.

3.10.3 Days to first harvest of fruits

First harvesting date of ripe fruits were recorded at 20 June 2011. Then the observation was calculated from the date of transplanting.

3.10.4 Days to last harvest of fruits

First harvesting date of ripe fruits were recorded at 9 July 2011. Then the observation calculated from the date of transplanting.

3.10.5 Fruit yield per plot

A pan scale balance was used to taken the weight of fruits per plot. It was measured by totaling of fruit yield from each unit plot separately during the period from first to final harvest and was recorded in kilogram (kg).

3.10.6 Weight of fruits per plant

It was measured by the following formula: Weight of fruits per plant (kg) = Total wt. of fruits from 3 sample plants / 3

3.10.7 Fruit yield per hectare

It was measured by the following formula

Fruit yield per hectare (ton) = Fruit yield per plot (kg) x 10000 / Area of plot in Square meter x 1000

3.11 Analysis of data

The data of different yield components and yields were statistically analyzed to find out the significance of the difference among the treatments. The analysis was performed by F-test, and the significance of the difference between pairs of treatment means was evaluated by the Least Significant Different (LSD) test at 5% and 1% level of probability.

CHAPTER IV

RESULTS AND DISCUSSION

The results of the experiment carried out under field conditions are presented in different Tables. The experiment was conducted to study the response of summer tomato to chemical fertilizers, manure and lime. The results are presented and discussed under the following parameters.

4.1.1 Plant height

The effect of chemical fertilizers, manure along with lime on plant height of summer tomato was significant throughout the growth period (Figure 1). Plant height of summer tomato was observed at different Day's After Transplanting (DAT). At 15 Day's After Transplanting (DAT), the tallest plant (36.2cm) was observed in the treatment T_4 receiving 1000kg poultry manure/ ha which was statistically significant with T_1(cowdung) and T_2 (chemical fertilizer). While, the shortest (17cm) was recorded in T_3 treatment applying lime only. However, at 30, 45 & 65 DAT, the tallest plant (69.31 cm, 83.22cm and 93.11 cm) was observed in the treatment applied with chemical fertilizer and the shortest plant (50.94 cm, 67.11 cm and 74.22 cm) was recorded in the treatment with application of lime which was statistically similar with treatment T_5 i.e. control. It was found that the maximum plant height (131.10 cm) in tomato when application of 250kg N, 50kg P, 83 kg K, 30kg S, 5kg Zn, 1 kg B, 1kg Mo and 5000kg cowdung /ha (BARI, 2007).

4.1.2 Number of leaves per plant

Number of leaves per plant of summer tomato varied significantly throughout the growth period (Fig. 2). Number of leaves of summer tomato was recorded at 15 DAT, 30 DAT and 45 DAT. At 15 days after transplanting (DAT), the maximum number of leaves (10.56) was found in the treatment T_4 receiving 1000kg poultry manure/ ha which was statistically identical with the treatment T_1, T_2 and T_3. The minimum number of leaves (8.22) was recorded in T_5 (control) treatment. However, at 30 DAT and 45 DAT the maximum number of leaves (31 and 50.56) was recorded with application of chemical fertilizer and minimum was recorded in T_3.

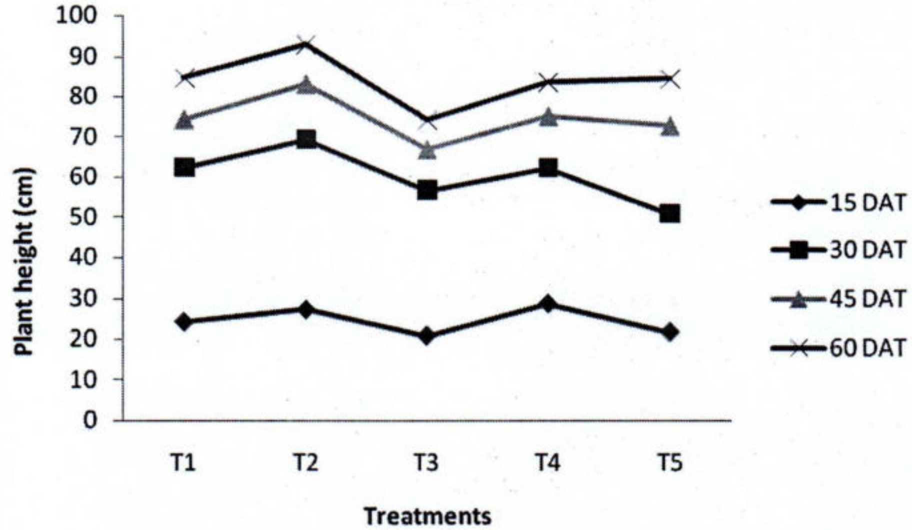


Fig 1: Showing plant height (cm) of Summer Tomato at different days after transplanting

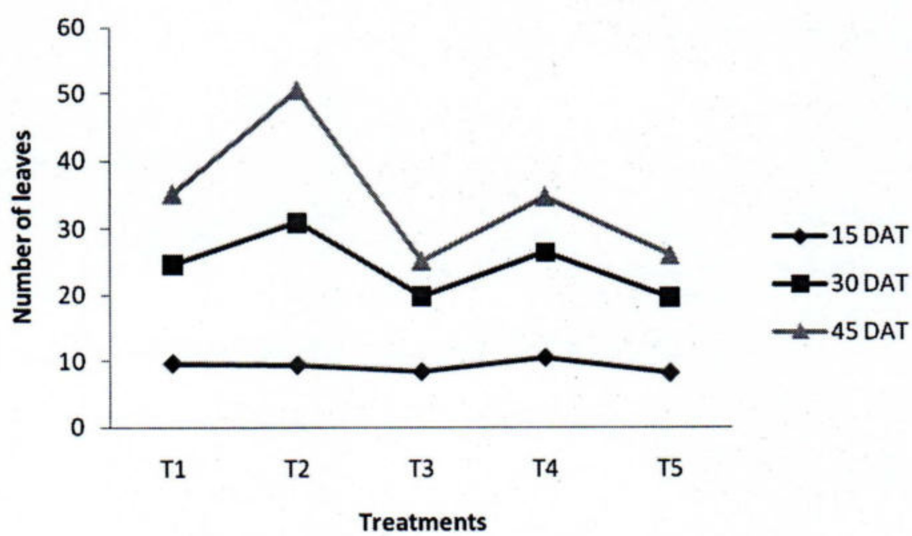


Fig 2: Showing number of leaves of Summer Tomato at different days after transplanting

4.1.3 Root fresh weight

Root fresh weight of summer tomato varied significantly with variation in fertilizer application. The maximum root fresh weight(38.2g/plant) was recorded in treatment T_2 receiving 550 kg N/ha, 450 kg P /ha, 250kg K/ha (Fig.3). On the other hand, minimum root fresh weight (11.59 g) was recorded in T_3 which was statically identical with T_1, T_4 and T_5. This might be due to the application of various manures and chemical fertilizers.

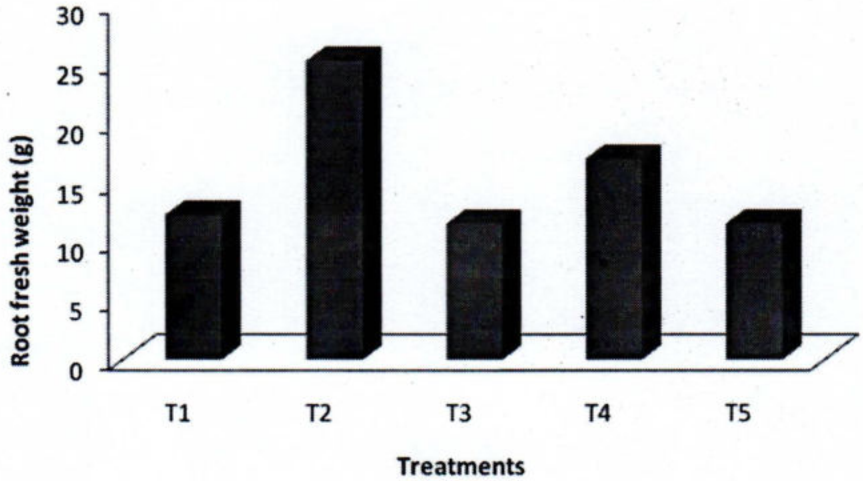


Fig 3: Showing root fresh weight (g) of Summer Tomato after harvesting

4.1.4 Root dry weight

Root dry weight of summer tomato varied significantly with variation in fertilizer application. The treatment T_2 receiving 550 kg N/ha, 450 kg P /ha, 250kg K/ha that produced the maximum dry weight of root (6.21 g/plant) (Fig.4). On the other hand, T_3 produced the minimum root dry weight (2.78 g) which was statically identical to T_1, T_4 and T_5. This might be due to the application of various manures and chemical fertilizers.

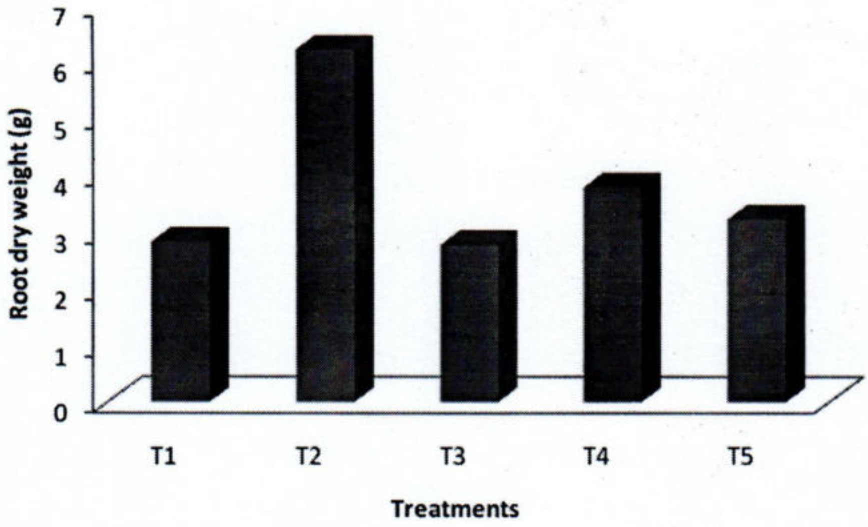


Fig 4: Showing root dry weight (g) of Summer Tomato after harvesting and oven drying

4.1.5 Shoot fresh weight

Shoot fresh weight of summer tomato varied significantly with variation in fertilizer application. The maximum shoot fresh weight was recorded in treatment T_2 receiving 550 kg N/ha, 450 kg P /ha, 250kg K/ha produced the maximum fresh weight of shoot (343.2 g/plant). On the other hand, minimum shoot fresh weight (90.22 g) was recorded in T_3 which was statically identical with T_1, T_4 and T_5. This might be due to the application of various manures and chemical fertilizers.

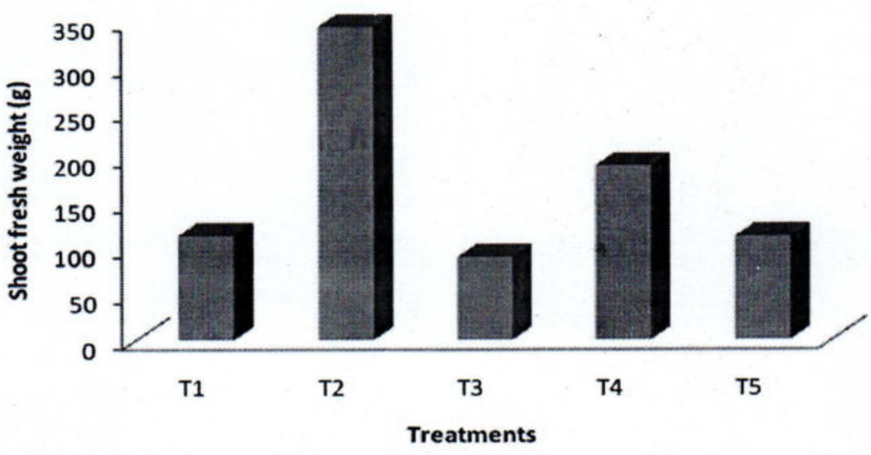


Fig 5: Showing Shoot fresh weight (g) of Summer Tomato after harvesting

4.1.6 Shoot dry weight

Shoot dry weight of summer tomato varied significantly with variation in fertilizer application. The maximum shoot dry weight was recorded in treatment T_2 receiving 550 kg N/ha, 450 kg P /ha, 250kg K/ha produced the maximum dry weight of shoot (60.15 g/plant). On the other hand, minimum shoot dry weight (17.46 g) was recorded in T_3 which was statically identical with T_1, T_4 and T_5. This might be due to the application of various manures and chemical fertilizers for growth promotes higher dry weight of shoot per plant.

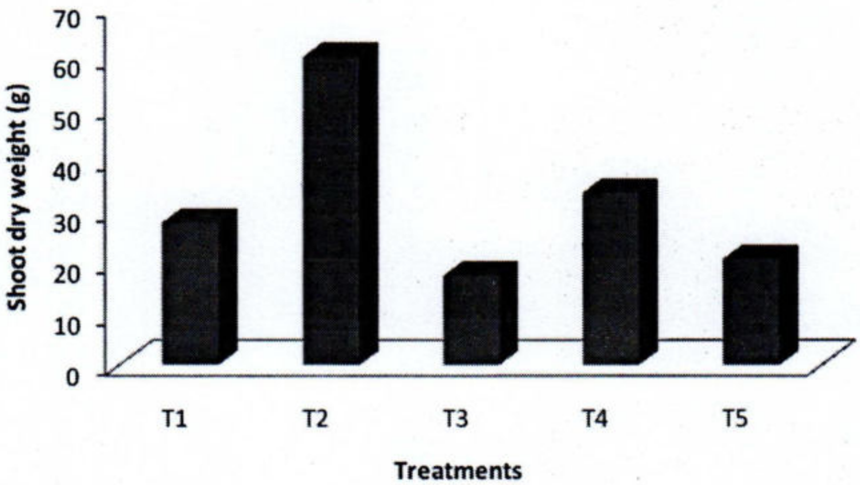


Fig 6: Showing Shoot dry weight (g) of Summer Tomato after harvesting and oven drying

4.1.7 Fruit fresh weight

Fruit fresh weight was significantly varied with different treatments chemical fertilizers, manures and lime are shown in Fig. 7. The maximum fruit fresh weight (520 g/ plant) was found in treatment T_2 receiving 550 kg N/ha, 450 kg P /ha, 250kg K/ha. Treatment T_1, T_3, T_4 and T_5 were statistically identical in recording fruit weight of the crop. The lime treatment produced the minimum fruit weight (2.8 g/plant).

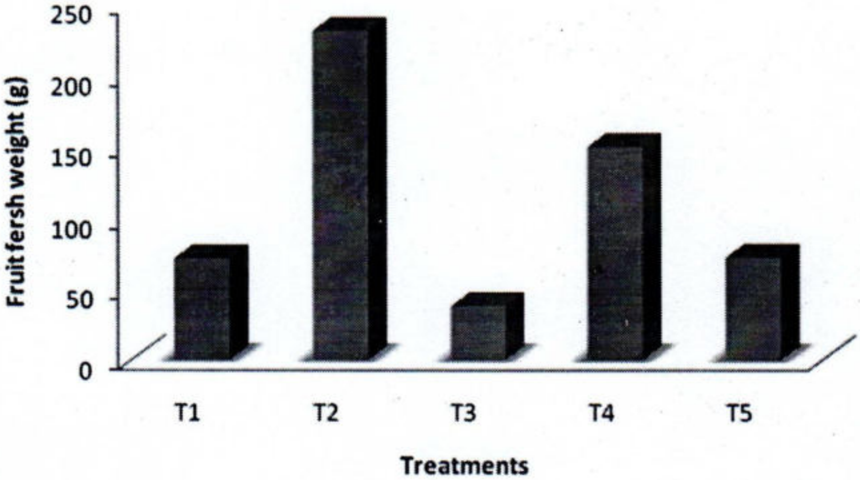


Fig 7: Showing fruit fresh weight (g) of Summer Tomato after harvesting

4.1.8 Calcium content in plant

Calcium content in the plant varied significantly with application of different organic and inorganic fertilizer (Fig. 8). The highest calcium content in plant (6.81 mg % Ca) was recorded in T_1 treatment which was statistically similar with T_2, T_3 and T_4. However, the lowest calcium content was recorded in T_5 (control). Calcium content in plant was significantly increased over control of summer tomato due to the residual effect of poultry manure along with soil test basis lime and cowdung.

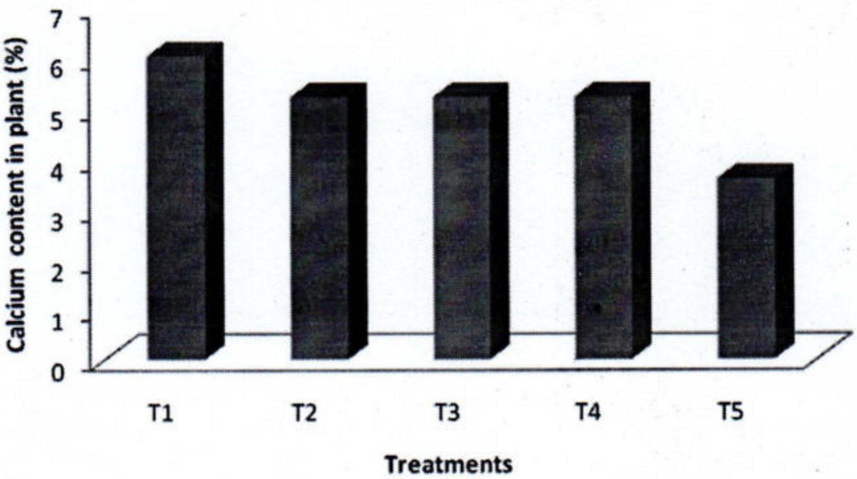


Fig 8: Showing Calcium content in plant (%) of Summer Tomato after harvesting and oven drying

4.1.9 Nitrogen content in plant

Nitrogen content in plant of summer tomato varied significantly with variation in fertilizer application. The maximum nitrogen content was recorded in treatment T_2 receiving 550 kg N/ha, 450 kg P /ha, 250kg K/ha produced the maximum nitrogen content (0.31%). On the other hand, minimum nitrogen content (0.06%) was recorded in T_3 which was statically identical with T_1, T_4 and T_5. This might be due to the application of various manures and chemical fertilizers for higher nitrogen content in plant. Nitrogen content in plant was significantly increased over control of summer tomato due to the residual effect of poultry manure along with soil test basis chemical nitrogenous fertilizers.

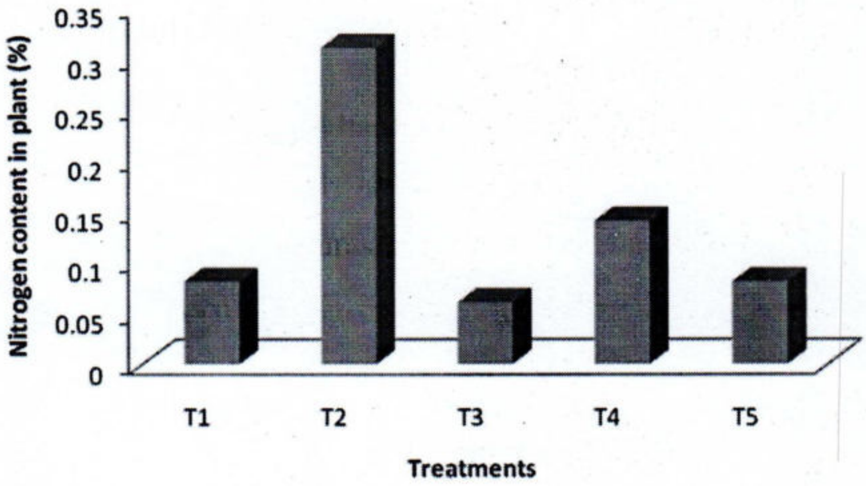


Fig 9: Showing Nitrogen content in plant (%) of Summer Tomato after harvesting and oven drying

4.1.10 Potassium content in plant

Potassium content in the plant varied significantly with application of different organic and inorganic fertilizer (Figure 8). The highest potassium content in plant (42.67 ppm) was obtained in T_2 treatment which was statistically identical with T_3, T_4 and T_5. However, the lowest potassium content was recorded in T_1 (cowdung). Potassium content in plant was significantly increased over control of summer tomato due to the residual effect of poultry manure along with soil test basis lime and cowdung.

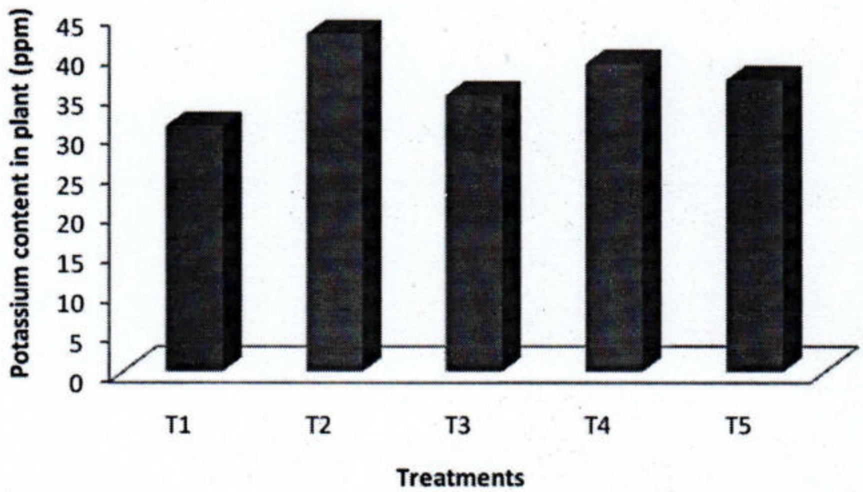


Fig 10: Showing Potassium content in plant (ppm) of Summer Tomato after harvesting and oven drying

4.1.11 Phosphorus content in plant

Phosphorus content in the plant varied significantly with application of different organic and inorganic fertilizer (Fig. 8). The highest phosphorus content in plant (43.33ppm) was found in T_2 treatment which was statistically identical with T_1, T_3 and T_4. However, the lowest phosphorus content was recorded in T_5 (control). Phosphorus content in plant was significantly increased over control of summer tomato due to the residual effect of poultry manure along with soil test basis lime and cowdung.

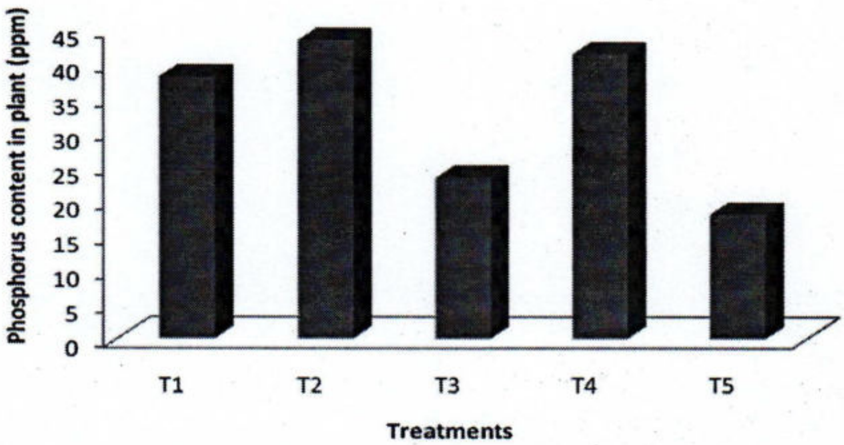


Fig 11: Showing Phosphorus content in plant (ppm) of Summer Tomato after harvesting and oven drying

4.1.12 Soil pH

Soil pH was significantly influenced by the residual effect of manures, lime along with chemical fertilizers on soil pH of the crop (Figure 12). Treatment T_3 significantly decreased the soil pH. The maximum soil pH (6.14) was received in T_1 treatment which was significantly superior to the rest of the treatments of the crop. The effect of T_2 and T_5 treatments was closely related to T_1 treatment followed by T_4 treatment and ranked second in position. The lowest soil pH(5.44) was noted in T_3 treatment.

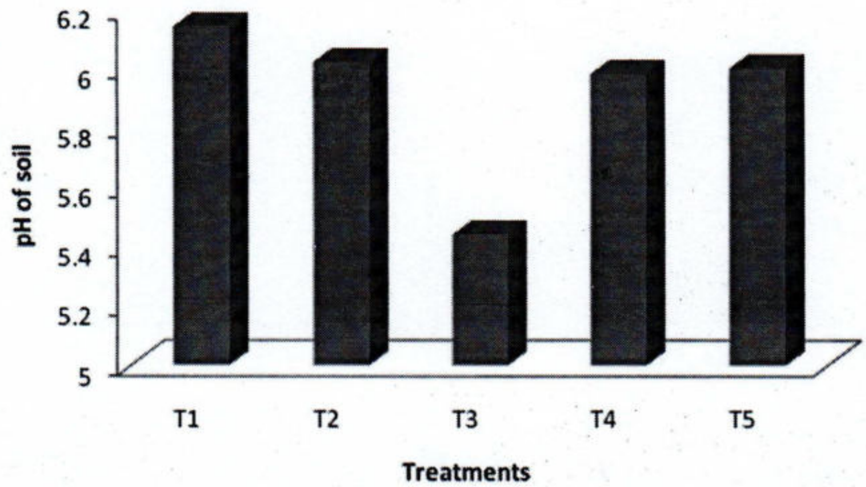


Fig 12: Showing pH of soil of Summer Tomato after harvesting and oven drying

4.1.13 Potassium content in soil

Potassium content in the soil varied significantly with application of different organic and inorganic fertilizer (Fig. 8). The highest potassium content in soil (38.00 ppm) was noted in T_4 treatment which was statistically identical with T_1, T_2 and T_3. However, the lowest potassium content was found in T_5 (control). Potassium content in soil was significantly increased over control of summer tomato due to the residual effect of poultry manure along with soil test basis lime and cowdung.

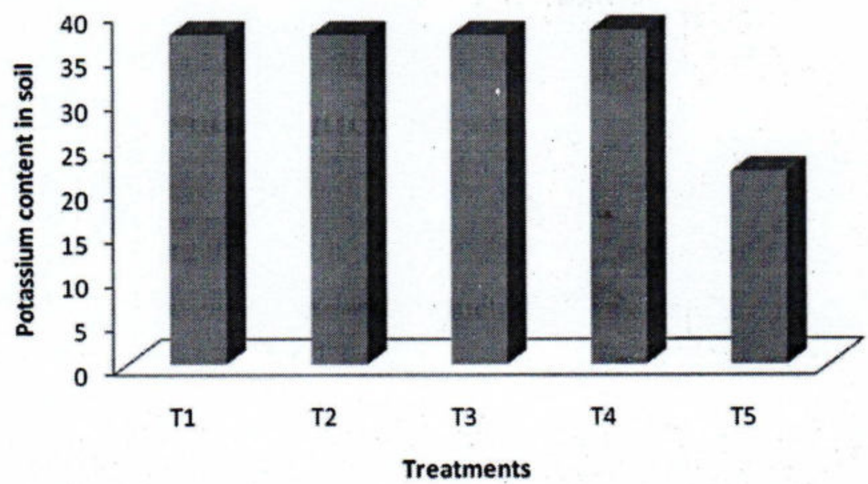


Fig 13: Showing Potassium content of soil (ppm) of Summer Tomato after harvesting and oven drying

4.1.14 Phosphorus content in soil

Phosphorus content in the soil varied significantly with application of different organic and inorganic fertilizer (Fig. 8). The highest phosphorus content in soil (42.67 ppm) was recorded in T_2 treatment which was statistically identical with T_1, T_3 and T_4. However, the lowest phosphorus content in soil (27.00 ppm) was recorded in T_5 (control). Phosphorus content in soil was significantly increased over control of summer tomato due to the residual effect of poultry manure along with soil test basis lime and cowdung.

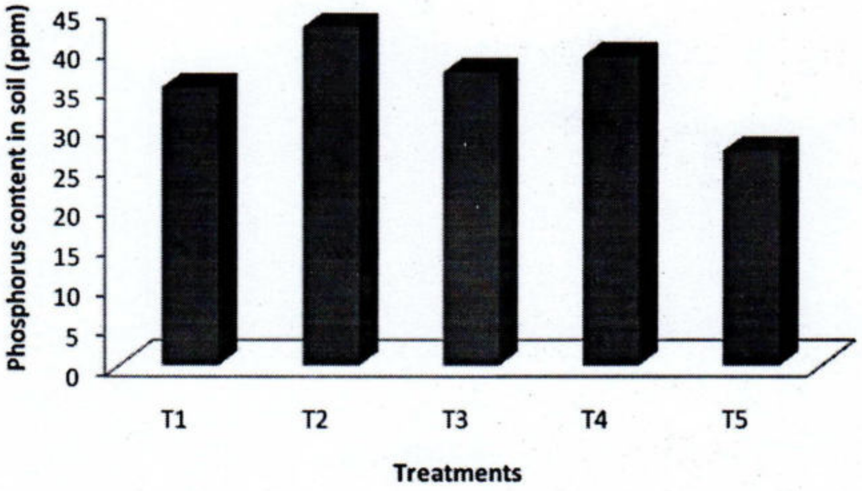


Fig 14: Showing Phosphorus content of soil (ppm) of Summer Tomato after harvesting and oven drying

4.1.15 Calcium content in soil

Calcium content in the soil varied significantly with application of different organic and inorganic fertilizer (Figure 8). The highest calcium content in soil (0.05 mg % Ca) was recorded in T_3 treatment which was statistically identical to T_1, T_2 and T_4. However, the lowest calcium content in soil (0.02 mg % Ca) was recorded in T_5 (control). Calcium content in soil was significantly increased over control of summer tomato due to the residual effect of poultry manure along with soil test basis lime and cowdung.

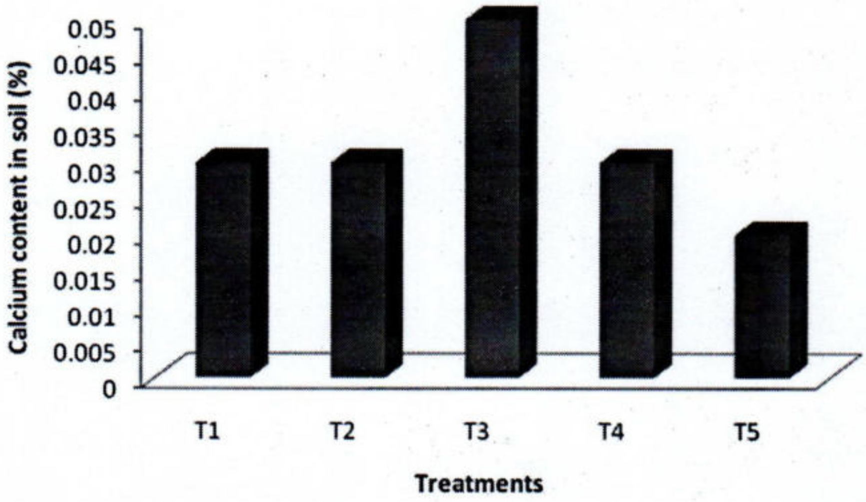


Fig 15: Showing Calcium content of soil (%) of Summer Tomato after harvesting and oven drying

4.1.16 Nitrogen content in soil

Nitrogen content in soil of summer tomato varied significantly with variation in fertilizer application. The maximum nitrogen content was recorded in treatment T_2 receiving 550 kg N/ha, 450 kg P /ha, 250kg K/ha produced the maximum nitrogen content (0.34%). On the other hand, minimum nitrogen content (0.08%) was recorded in T_3 which was statically identical with T_1, T_4 and T_5. This might be due to the application of various manures and chemical fertilizers for higher nitrogen content in plant. Nitrogen content in soil was significantly increased over control of summer tomato due to the residual effect of poultry manure along with soil test basis chemical nitrogenous fertilizers.

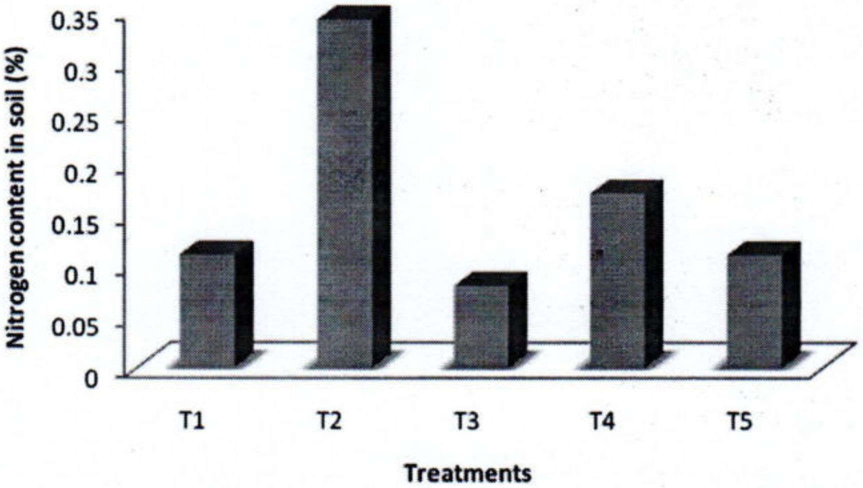


Fig 16: Showing Nitrogen content of soil (%) of Summer Tomato after harvesting and oven drying

4.1.17 Yield

There was a significant effect of chemical fertilizers, manures and lime on the yield of summer tomato (Figure 16). The maximum yield of tomato (35.9 t/ha) was noted in treatment T_2 receiving 550 kg N/ha, 450 kg P /ha, 250kg K/ha. The lowest value of yield of summer tomato (6.6 t/ha) was recorded in lime (T_3) treatment. BARI (2007) obtained highest yield of summer tomato due to the application of 250kg N, 50kg P, 83 kg K, 30kg S, 5kg Zn, 1kg B, 1 kg Mo and 5000 kg cowdung.

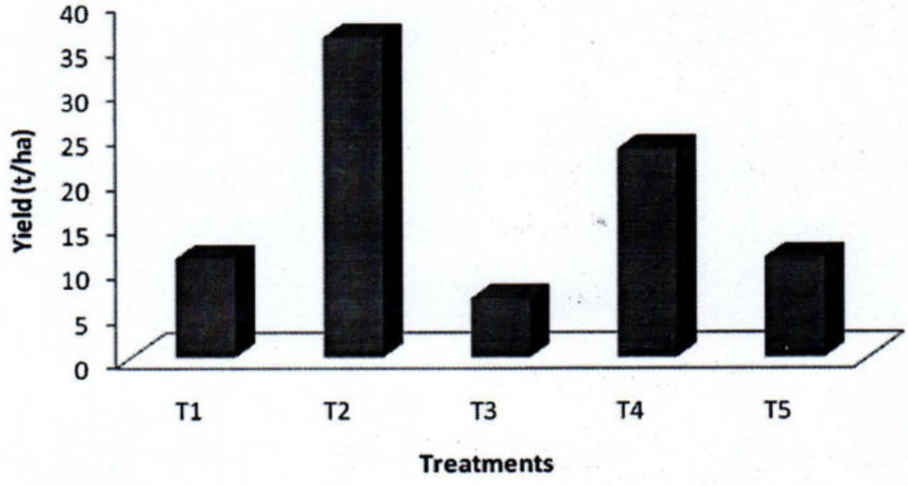


Fig 17: Showing Yield (t/ha) of Summer Tomato after harvesting

4.1.18 Soil health

Health of the soil varied significantly with application of different organic and inorganic fertilizer. Soil pH of the whole field was 5.56, whereas, after harvesting of the crop soil pH was increased in all the treatment except T_3 (Lime treatment) and the maximum pH value (6.14) was found in T_1 (Cowdung) treatment. On the other hand, phosphorus content was also increased in all the treatment, maximum phosphorus content (42.67 ppm) was found in T_2 treatment, whereas, initial soil contains only 8 ppm phosphorus.

Again, potassium content of the soil after cultivation of summer tomato with various treatments was observed higher value in every treatments than in the initial soil. The maximum value of potassium content (38 ppm) was found in T_4 (poultry manure). Moreover, highest calcium content of the soil after cultivation of summer tomato was 0.05% in the T_3 (Lime) treatment. Whereas, initial soil contains 0.02% Ca. In the initial soil nitrogen contains 0.08%, after cultivation of summer tomato which was increased to 0.34% in T_2 (Chemical fertilizer) treatment.

CHAPTER V

SUMMARY AND CONCLUSION

5.1 Summary

An experiment was conducted at the experimental field of the Department of Soil Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur during March, 2011 to June, 2011 to evaluate the suitability of summer tomato cultivation with organic and inorganic fertilizer application. The experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. The treatments of the experiment involved, T_1 (Cowdung); T_2 (Chemical fertilizer); T_3 (Lime); T_4 (Poultry manure); T_5 (Control).

A significant variation was observed among the treatment in respect of different parameters of summer tomato. In case of growth parameters of summer tomato, plant height of summer tomato was observed at different Day's After Transplanting (DAT). At 15 Day's After Transplanting (DAT), the tallest plant (36.2cm) was observed in the treatment T_4 receiving 1000kg poultry manure/ ha. While, the shortest (17cm) was recorded in T_3 treatment applying lime only. However, at 30 DAT, 45 DAT and 65 DAT, the tallest plant (69.31 cm at 30 DAT, 83.22cm 45 DAT and 93.11 cm 65 DAT) was observed in the treatment applied with chemical fertilizer and the shortest plant (50.94 cm at 30DAT, 67.11 cm 45 DAT and 74.22 cm 65 DAT) was recorded in the treatment with application of lime which was statistically similar with treatment T_5 i.e. control. While in case of number of leaves, at 15 days after transplanting (DAT), the maximum number of leaves (10.56) was found in the treatment T_4 receiving 1000kg poultry manure/ ha. The minimum number of leaves (8.22) was recorded in T_5 (control) treatment. However, at 30 DAT and 45 DAT the maximum number of leaves (31 and 50.56) was recorded with application of chemical fertilizer and minimum was recorded in T_3.

Again, root fresh weight of summer tomato varied significantly with variation in fertilizer application. The maximum root fresh weight was recorded in treatment T_2 produced the maximum fresh weight of root (38.2 g/plant). On the other hand, minimum root fresh weight (11.59 g) was recorded in T_3. The maximum root dry weight was recorded in treatment T_2 produced the maximum dry weight of root (6.21 g/plant). On the other hand, minimum root dry weight (2.78 g) was recorded in T_3 which was statically identical with T_1, T_4 and T_5.

Moreover, maximum shoot fresh weight was recorded in treatment T_2 produced the maximum fresh weight of shoot (343.2 g/plant). On the other hand, minimum shoot fresh weight (90.22 g) was recorded in T_3. While, maximum shoot dry weight was recorded in treatment T_2 produced the maximum dry weight of shoot (60.15 g/plant). On the other hand, minimum shoot dry weight (17.46 g) was recorded in T_3.

However, in case of different nutrient content in the plant, highest calcium content in plant (6.81 mg % Ca) was recorded in T_1 and the lowest calcium content was recorded in T_5 (control). The maximum nitrogen content was recorded in treatment T_2 (0.31%). On the other hand, minimum nitrogen content (0.06%) was recorded in T_3.

Again, The highest potassium content in plant (42.67 ppm) was found in T_2. However, the lowest potassium content was recorded in T_1 (cowdung). Moreover, the highest phosphorus content in plant (43.33ppm) was observed in T_2 treatment. However, the lowest phosphorus content was recorded in T_5 (control).

In case of soil pH, the maximum soil pH (6.14) wasobtained in T_1 treatment and the lowest soil pH (5.44) was observed in T_3 treatment. However, in case of different nutrient content in the soil, the highest potassium content in soil (38.00 ppm) was recorded in T_4 treatment. However, the lowest potassium content was recorded in T_5 (control). The highest phosphorus content in soil (42.67 ppm) was recorded in T_2 treatment. However, the lowest phosphorus content in soil (27.00 ppm) was received in T_5 (control).

Again, The highest calcium content in soil (0.05 mg % Ca) was recorded in T_3 treatment. However, the lowest calcium content in soil (0.02 mg % Ca) was recorded in T_5 (control).

The maximum nitrogen content was recorded in treatment T_2 produced the maximum nitrogen content (0.34%). On the other hand, minimum nitrogen content (0.08%) was recorded in T_3. The maximum yield of tomato (35.9 t/ha) was recorded in treatment T_2. The lowest value of yield of summer tomato (6.6 t/ha) was recorded in lime (T_3) treatment.

5.2 Conclusion

Application of chemical fertilizers 550 kg N/ha, 450 kg P /ha, 250kg K/ha increases the yield of summer tomato. The maximum yield of summer tomato along with chemical fertilizer was 35.9 t/ha. Among the organic fertilizers, highest yield (23.35 t/ha) was obtained with application of 1000 kg/ha of poultry manure.

On the other hand, different nutrient content in the plant found diverse due to application of organic and chemical fertilizer. NPK content in the plant was maximum with application of chemical fertilizer while calcium content was highest with the application of Lime. In case of soil sample, different nutrient content increase after cropping prior to cultivation. NPK content in the soil was maximum with application of chemical fertilizer.

5.3 Recommendation

Cultivation of summer tomato with the application of chemical fertilizer 550 kg N/ha, 450 kg P /ha, 250kg K/ha is suitable for the farmers of northern part of Bangladesh.

Similar study should be done to evaluate the effect of chemical fertilizer and organic manures along with nutrients to get maximum yield of summer tomato in other locations of the country.

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CHAPTER VI

Appendix

Appendix -I. Effect of chemical fertilizers, manures and lime on the growth of plant (plant height) and number of leaves of the plant

Treatments	Plant height (cm) at				Number of leaves		
	15 DAT	30 DAT	45 DAT	65 DAT	15 DAT	30 DAT	45 DAT
T_1	24.21 ab	62.33 ab	74.44 b	84.66 ab	9.67 ab	24.66 ab	35.22 b
T_2	27.40 ab	69.31 a	83.22 a	93.11 a	9.44 ab	31.00 a	50.56 a
T_3	20.84 b	50.94b	67.11 b	74.22 b	8.44 ab	19.89 b	25.22 c
T_4	28.77 a	62.28 ab	75.33 ab	83.67 ab	10.56 a	26.44 ab	34.78 b
T_5	21.79 ab	56.72 ab	73.00 b	84.67 ab	8.22 b	19.67 b	26.11 c
Level of Sig.	**	**	*	*	*	*	**
CV (%)	14.33	11.37	5.97	7.60	11.92	16.50	11.79

N.B. T_1= Cowdung+ Summer Tomato; T_2= Chemical fertilizer (NPK) + Summer Tomato; T_3= Lime+ Summer Tomato; T_4= Poultry manure+ Summer Tomato; T_5= Summer Tomato (Control);

Appendix- II. Effect of chemical fertilizers, manures and lime on the fresh and dry weight of the root and shoot, Ca and N content in plant

Treatments	Root fresh weight (g)	Root dry weight (g)	Shoot fresh weight (g)	Shoot dry weight (g)	Fruit fresh weight (g)	Calcium content in plant (%)	Nitrogen content in plant (%)
T_1	12.30 b	2.83 b	113.5 b	27.72 bc	71.13 b	6.01 a	0.08 b
T_2	25.19 a	6.21 a	343.2 a	60.15 a	230.9 a	5.21 a	0.31 a
T_3	11.59 b	2.78 b	90.22 b	17.46 c	37.59 b	5.21 a	0.06 b
T_4	17.02 b	3.79 b	190.6 b	33.57 b	150.1 ab	5.21 a	0.14 b
T_5	11.61 b	3.23 b	112.1 b	20.68 c	72.26 b	3.61 b	0.08 b
Level of Sig.	**	*	**	**	*	*	**
CV (%)	13.01	19.36	11.15	18.71	10.72	14.17	12.79

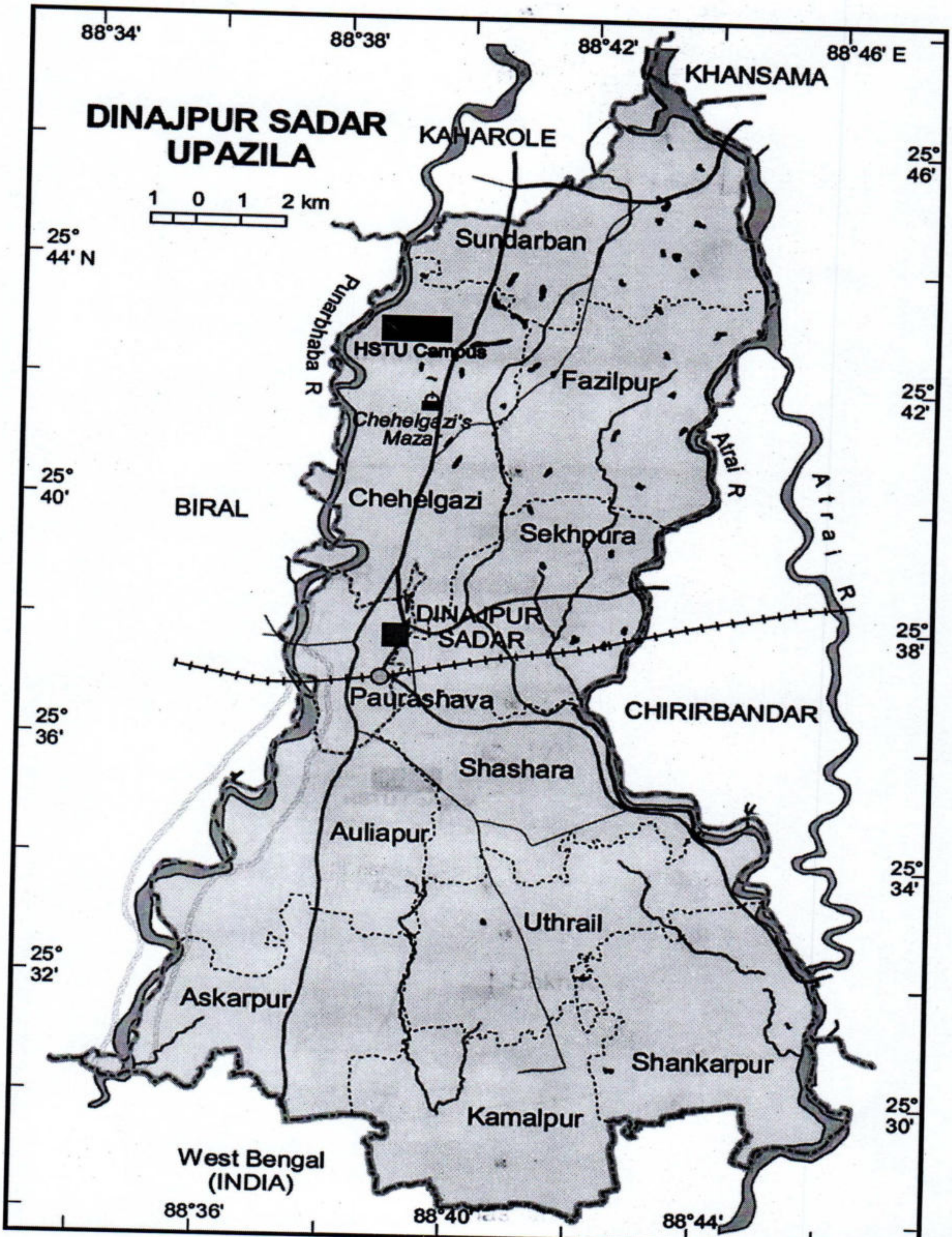
N.B. T_1= Cowdung+ Summer Tomato; T_2= Chemical fertilizer (NPK) + Summer Tomato; T_3= Lime+ Summer Tomato; T_4= Poultry manure+ Summer Tomato; T_5= Summer Tomato (Control);

Appendix- III. Effect of chemical fertilizers, manures and lime on the content of K, P in plant and pH of the soil and K, P, Ca and N Content in the soil

Treatments	Potassium content in plant (ppm)	Phosphorus content in plant (ppm)	pH of soil	Potassium content in soil (ppm)	Phosphorus content in soil (ppm)	Calcium content in soil (%)	Nitrogen content in soil (%)
T_1	31.00 c	38.00 b	6.14 a	37.33 a	35.00 b	0.03	0.11 b
T_2	42.67 a	43.33 a	6.02 b	37.33 a	42.67 a	0.03	0.34 a
T_3	35.00 b	23.33 c	5.44 c	37.33 a	37.00 b	0.05	0.08 b
T_4	39.00ab	41.33 a	5.98 b	38.00 a	39.00ab	0.03	0.17 b
T_5	37.00 b	18.00 d	6.00 b	22.00 b	27.00 c	0.02	0.11 b
Level of Sig.	**	**	**	**	**	ns	**
CV (%)	5.72	3.61	1.15	2.60	6.23	19.35	18.38

N.B. T_1= Cowdung+ Summer Tomato; T_2= Chemical fertilizer (NPK) + Summer Tomato; T_3= Lime+ Summer Tomato; T_4= Poultry manure+ Summer Tomato; T_5= Summer Tomato (Control);

Appendix- IV. Experimental site (Map of Dinajpur Sadar Upazila Showing the Research Field).



Appendix- V. Monthly record of temperature, relative humidity, rainfall and sunshine during the period from November, 2010 to March, 2011

Year	Months	**Air temperature (^{o}C)			**Relative humidity (%)	*Rainfall (mm)	*Sunshine (hrs)
		Maximum	Minimum	Average			
2010	November	29.46	19.02	24.24	83.40	03.9	203.9
	December	25.81	13.51	19.66	80.93	41.60	193.0
2011	January	22.24	10.68	16.46	83.71	01.1	132.9
	February	27.32	15.33	21.33	74.18	12.0	191.3
	March	29.96	19.73	24.85	73.74	32.6	217.2

* Monthly total

** Monthly average

Source: Weather Yard, Department of Irrigation and Water Management, Records of Climatological observation, Bangladesh Agricultural University, Mymensingh-2202

Fig. 19:Fresh fruit of Summer tomato cultivation in the field of Soil Science Department

Fig.20:Summer tomato cultivation in the field of Soil Science Department

Fig. 23:Collection of data in the field(plant height)