Understanding the cultivated tomato (lycopersicon esculentum)

Food & Diet, Organic Food

Introduction

1. 1General

The cultivated tomato (Lycopersicon esculentum) is one of the most popular and extensively consumed vegetable crops. The tomatoes are grown in a wide range of climates under protection in plastic greenhouses, in heated greenhouses and in the field. Thefamilyof tomato is Solanaceae which originated in Peru but was domesticated in Mexico. Tomatoes are short-lived perennials cropped as annuals however, killed by frost outdoors, in greenhouses, plants may be cropped for 2 years or longer.

1. 2Background research to the study

1. 2. 1 Aims

The aims of this project were to see how field grown tomatoes are affected by 3 different concentrations of insecticides in north Turkey provinces in Nicea and in comparison to the maximum residual level (MRL) of the European Union and Russian markets.

The project was a practical experiment which showed growers how to use less insecticide than they are currently, this reason can create higher crop prices, more numerous export levels, betterhealthand safety production and ameliorated production techniques. Furthermore one of the main ideas for the project was to show to the growers that using less insecticide could give the same quality as high use level of insecticide. The experiment also could show that to change old traditional methods and develop good agriculture practices which could reduce the use of pesticides in turn harvest higher yield averages.

1. 2. 2 Objectives

To change farming method and production techniques of the crop.

To grow healthy and safety crop.

To get less MRL on the crop and increase the export amount.

To show different control method such as biological and start to use of IPM.

To show with small land segmentation difficult to export but with co-operatives can help to export more.

To analyse tomato sector in the world and in Turkey.

1. 3 Overview of the tomato sector in Turkey

Tomato production accounted for approximately 38% of all vegetable production in Turkey in 2009 (USDA, 2009). The crop could be grown throughout Turkey but for fresh tomatoes consumption could be grown in the Mediterranean region, typically green houses. For instance Antalya South Turkey was a significant city for the tomato sector it was the top tomato producing province, growing about 17% of all tomatoes in 2009 (USDA, 2009). In Turkey, the production of tomato had a few advantages at the time of writing; a strong domestic consumption of fresh vegetables, suitable conditions and a young rapidly growing population (Keskin. G. et al 2008).

On the other hand the country had some significant issues; one of the important issues was the lack of knowledge during the growth, inadequate organization, land segmentation, the lack of storage and protection facilities, less compliance of the cultivation methods to the rules of good agriculture practices (GAP) and the complexity of marketing channels for vegetable and high post-harvest production losses (Keskin. G. et al 2008). All these are vital factors for success in the sector. In Turkey, the climate has supported the growth of the fruit and vegetable sector which has led to its status as a major producer (USDA, 2009).

1. 4Production quantity in Turkey

The figure 1 showed the general production of tomato which had increased in the previous 20 years from the time of writing. The figure went up 500% between 1990 and 2009. 15% of the production of tomato was grown in glass houses and the remainder of the production was from open field. Glass houses had become a more popular system than open field which had less advantages and in 1995 glass house tomato production was at 9. 000 ha then the figure increased 117% to 19. 900 ha in 2007 (Keskin. G. et al 2008). Approximately 30% of Turkish tomato production is processed into products such as tomato paste, tomato juice, ketchup, tomato puree, and chopped tomatoes (USDA, 2009).

Figure 1 showed the amount of tomatoes produced in Turkey within last 19 years from the time of writing.

Figure 2 showed how many fresh tomatoes tonnes produced from 2000 to 2009

In figure 2, the figure was 5, 856, 500 fresh the production tonnes in 2000 then decreased to 5, 559, 500 tonnes in 2005 subsequently the amount increased to 7, 205, 961 tonnes in 2009.

1. 4. 1Loss production of tomato

There were some huge figures for loss of production of the crop which included during the growth from fields, storage and post-harvest life. In figure 3, the amount was 1, 333, 500 tonnes in 2000 then increased to 1, 507, 500 tonnes in 2005. In addition last 2 years the figure decreased slightly to 1, 491, 756 tonnes which is shown that growers did not have hightechnologyfor non-loss production especially between 2000 and 2005.

In this case, that situation the cost can be high for growers therefore growers can require high crop prices. This issue can cover the following factors; lack of knowledge during the growth, the lack of enough storage and protection facilities and non-compliance of the cultivation methods to the rules of good agriculture practices (GAP) all these factors can create loss production of the crop.

Generally in Turkey yield per ha was about 10% lower than the EU25 average. Production technology was also significant and the higher yields obtained from hydroponic cultivation techniques compared to conventional production methods play a significant role in explaining differences in yields (Keskin. G. et al 2008). In addition approximately 15 % of tomato production was lost during harvest and these losses are between 4-10% in the major producing countries of the EU (Keskin. G. et al 2008).

Figure 3 showed how many tonnes of loss production of tomatoes in Turkey from 2000 to 2007.

1. 5Tomato's in the world

Tomato was one the world`s largest vegetable crops from the time of writing. Production of tomato fruit was commercially significant throughout the world for both the fresh market and the processedfoodindustries and the crop is grown in sub-tropical, tropical and temperate areas using many diverse production system(J. G. Atherton and J. Rudich, 1986). In recent years, the demand for tomato production has increased on the international market. In 2009, the production of tomatoes was over 130 million tonnes in the world (Faostat, 2009).

Turkey has an important position for the production of tomato, moreover, in the world approximately 7% of the production tomato produced in Turkey. In addition the country is the fourth with 10, 745, 572 tonnes which is followed by India. In the table 1 China is the world's largest producer of tomatoes 34, 120, 040 tonnes and the USA is the second largest at 14, 141, 850 tonnes.

1. 6Export of tomatoes in Turkey

In figure 4, generally the crop export increase in the last 19 years had a figure of 33, 586 tonnes in 1990 then the amount increased to 119, 889 tonnes in 10 years which was increased about 270% export. In addition there is a huge rise in tomato export in Turkey from 119, 889 tonnes in 2000 which rose to 250, 182 tonnes in 2005 which doubled, subsequently the amount increased dramatically to 550, 515 tonnes in 2009.

Figure 4 shows the last 20 years how many fresh tomato tonnes were exported from Turkey to the rest of the world

In Turkey, tomato export is highly seasonal and the highest level of export is between February and June. Generally the exports are low between July and November. In figure 4 the number of exports is still not enough in comparison with the amount of crops which are actually produced, which means that the problems are significantly reducing the quality of the crop which could potentially be exported.

In 2009 the production was 7, 205, 961 tonnes fresh tomato (figure 2) and at the same year the production export was 550, 515 tonnes fresh tomato which is approximately 5% exported and this number are non-satisfaction for growers and exporters. Although the Turkish people will consume a large number of tomatoes this figure is still relatively low.

Turkey has some serious problems for exports; small scale production generally growers are family businesses and the average production area is about 2-4 ha which is much lower than the EU grower average area. Another significant export problem is the inadequacy of farmer’s organization especially in relation to the marketing of their produce, seasonal production and lack of quality, lack of transport facilities, the problem of competition with other countries for example Spain, Italy and Holland who have a more efficient production system such as hydroponic cultivation and mostly production is from glass-house, non-annual production plan. Pesticide residual problems are the main problem in relation to the export of tomatoes from Turkey. Residual problems often can be seen in Turkey more than the EU countries generally, this problem is caused by a lack of knowledge amongst growers on the correct applications and dosages of the chemicals.

In 2008, there was a problem, Russia banned imports of certain Turkish fresh fruit and vegetable products, including fresh tomatoes (USDA, 2009) Russian officials stated that the ban was instituted because of continued detections of high levels of pesticide residues on Turkish products since the beginning of 2008 (USDA, 2009).

1. 7Export market

Generally Turkey`s export prices are lower compared to some Mediterranean countries such as Greece and Italy. Russia is a significant exporter market and the top destination for Turkish fresh tomatoes as the figure 5 shows is Russian with 237, 859 tonnes of fresh tomatoes being exported in 2009 which is approximately 3% production of the crop exported and over 50% of export held.

Bulgaria accounted for 96, 942 tonnes of fresh tomatoes in 2009 which is the second destination market and about 20% of export. Ukraine is 45, 449 tonnes which is about 10% of export and followed by Bulgaria. The amount of exports Romania was 34, 046 tonnes similar to Saudi Arabia which is 23, 668 tonnes. In addition the crop can be exported to Germany which is Central Europe 6, 871 tonnes in 2009.

The location of Turkey can be an advantage to export to Russia, Bulgaria, Romania, Ukraine and Saudi Arabia who are geographically close to the country and this advantage can cover; easier exports, shorter transport distance thus costing less and reducing the risk of death from post harvest life. In addition In Germany, about 4 million Turkish people populate the country. Therefore the crop can export to Turkish supermarkets in Germany which can be easier than the other EU markets. The wealth and traditions of the markets near by can also be a factor for export, tomatoes may or may not feature in their cuisine.

Figure 5 show top 6 export market of tomatoes

1. 8Strength and weakness of Turkey

Table 2 shows there are some strengths and weakness factors for production and trade in Turkey

StrengthsWeakness

Suitable conditions which can be grown tomato in every region.

Natural conditions can provide possibility for more production of the crop.

Size of domestic market i. e. 75 million people and has young population with high consumption per capita.

Some structural problem; the low productivity in comparison with EU countries also small and fragmented land structure.

Lack of a definite supporting policy.

Big production losses from producer to consumer.

Complexity of marketing structure.

Lack of storage units.

Inefficient study of producer unions and cooperatives.

Need for more progress on traceability and standards.

Loweducationfor growers in comparison to the EU growers and still tradition farm methods.

Staying out of commodity preference related to trade with the EU.

(Keskin. G. et al 2008).

Generally, table 2 can show more weakness than strengths therefore Turkish growers need to improve production and their trade system. The main problem of the Horticulture sector in Turkey can be caused by all of these weakness factors created by an inadequate economy.

2. Literature view

Generally, the main aspect of the project is to show that growers can grow tomatoes with a less use of pesticide which can show a better quality yield because in this area (Nicea) tomato growers often spray their crops with insecticide which produce high insecticide residual levels on the crop and this reason will bring lots of problems. The growers are uneducated in this subject with a lack of restrictions from bodies of power.

The project will show growers;

The benefits of the use of less pesticide which can create lower residue levels.

Growing healthy and safe crops.

How the use of less pesticide can increase the crop prices and export with less residue levels.

The benefits of stopping the use of old traditional farming methods.

Start to use GAP (good agriculture practice) which can reduce production losses from planting to harvest.

Show the benefits of co-operatives, which can create more power and knowledge.

This project will help growers especially tomato growers in the area of Nicea, Turkey. For example, since 2008 the price of the crops were not good enough because of the residual levels in the fruits when gone to market therefore growers will be more careful in the future and this project can help to sell to European Union countries and the Russian markets.

Some of the constraints of researching for the project have been the lack of literature in this exact field. Generally, the research projects relating to this subject are in conjunction with the growth of tomatoes for the processing food market for example tomato based products such as purees or salsas.

As the open field growth method provides many problems, some detrimental to the crop for growers therefore the preferred method of marketable fresh tomatoes is under glass.

In Italy, University of Foggia department of foodsciencehad been researched `Pesticide residues in tomato in open field` they are mainly focused on particularly pesticide which are Benalaxyl, Chlorothalonil and Methomyl. In Southern Italy cultivation for the processing industry or for consumption as a fresh product is wide spread and is performed both in open field and in greenhouses. The chemical protection of processing tomatoes is commonly carried out by scheduled treatments, using different kinds of pesticides: Benalaxyl, Chlorothalonil and Methomyl are among those most extensively used in this area. Benalaxyl (methyl-N-phenylacetyl-N-2, 6-xylyl alalinate) is a xylem-systemic fungicide, whereas Chlorothalonil (2, 4, 5, 6-tetrachloro-isophthalonitrile) is a not-systemic, broad-spectrum fungicide; they are commonly used in conjunction with copper, to increase the spectrum of action and the effectiveness of the treatments. Finally, methomyl (S-methyl-N-[(methylcarbamoyl)-oxy] thioacetimidate) is an insecticide, toxic to insects both through direct contact and by ingestion (University of Foggia, 2004). Also importance of this crop considering that the EU maximum residue levels (MRL) of the above mentioned pesticides have been recently revised (EU, 2000) further study seems necessary (University of Foggia, 2004).

A project, which has some significance to the research project, is based on pesticide residues in tomatoes in Ghana this study evaluates the residue levels of select pesticides used on tomato crops in Ghana that are likely to have accumulated in the tomatoes during application. The results obtained confirm that pesticide residues were indeed present in the tomatoes and further analysis quantified the amount present.

Analysis of some organochlorine and organophosphorus residue levels in the fruits indicated that chlorpyrifos, which is an active ingredient of pesticides registered in Ghana under the trade name Dursban 4E or Terminus 480 EC for use on vegetables, has the greatest residue level of 10. 76 mg/kg. The lowest residue level observed was that of pirimiphos-methyl with 0. 03 mg/kg (D. K. Essumang, et al, 2008).

The risk assessment showed cancer risks for adults and children due to the presence of endosulfan and chlorpyrifos. Endosulfan is not registered in Ghana as a pesticide for use on vegetables; therefore the detection of endosulfan in several samples indicates misuse of agrochemicals among Ghanaian farmers (D. K. Essumang, et al, 2008).

University of Ambedkar had been researched for Estimation of Multiclass Pesticide Residues in Tomato (Lycopersicon esculentum) and Radish (Raphanus sativus) vegetables by Chromatographic Methods. Multiclass pesticide residues endosulphan, cypermethrin, monocrotophos and chlorpyriphos have been estimated qualitatively and quantitatively in two vegetables, tomato (Lycopersicon esculentum) and radish (Raphanus sativus) by adopting gas liquid chromatographic and high performance liquid chromatographic methods. In the sample of tomato two pesticides, endosulphan and cypermethrin and in radish four pesticides. Endosulphan, cypermethrin, monocrotophos and chlorpyriphos were found. The concentrations of the detected pesticides were determined from the area of the peaks (Kummar , D. et al, 2008).

In Turkey, university of Canakkale Onsekiz Mart Food Engineering Department had been researched for fate of `Endosulfan` and `Deltamethrin` residues during tomato paste production. This study, the effects of tomato paste processing steps on pesticides with active ingredient endosulfan and deltamethrin were investigated in Biga/Canakkale.

Residue data were obtained by analyzing samples taken during harvesting, taken after washing and chopping, taken after pulping (pulp and pomace) and taken from the tomato paste with GC-ECD. In the process of making tomato paste, washing decreased endosulfan and deltamethrin, 30. 62% and 47. 58%, respectively. Pre-heating, pulping, evaporation and half-pasteurization increased deltamethrin 2. 33% while decreasing endosulfan 66. 5% after washing. The whole process decreased endosulfan and deltamethrin, 76. 8% and 46. 3%, respectively. The residues were mostly collected in pomace (Uysal, C. et al 2006).

The European Food Safety Authority (EFSA) has published its Annual Report on Pesticide Residues, which provides an overview of pesticide residues in food in the European Union during 2008 and assesses the exposure of European consumers to those residues through their diets. The report shows that 96. 5% of the samples analysed comply with the maximum residue levels (MRLs) of pesticides permitted for food products in the EU (EFSA, 2010). The report says that 3. 5% of all analysed samples exceed the legal Maximum Residue Levels.; in 2007, 4. 2% of pesticides exceeded the legal MRL limits. In total, more than 70, 000 samples of nearly 200 different types of food were analysed for pesticide residues. The monitoring methods used by EU Member States allow for up to 862 different pesticides to be detected (EFSA, 2010).

Food & Fairness Briefing No. 1 EU have done research in to which pesticides are banned in Europe. There are tables, which show the banned active ingredients, or severely restricted in the European Union therefore if any banned substance used for the experiment, it’s impossible to sell crops to the EU. That briefing will give some information which chemical substance can’t be used for the EU markets. (Food fairness briefing no. 1, 2008).

University of Harran had been done researched on Pesticide using in agriculture in Sanliurfa. SAP (South and East Anatolian Project) region is a large area which has an intensive agricultural production and increasing food consumption connected with a continuously increasing population. Nowadays as a matter of fact, the aim in agriculture is to get the yield of good quality and high in amount from the unit area. Therefore, pesticides and chemical fertilizers have been used widely in agriculture. Distribution of different crops in the agricultural area in Sanliurfa and the annual amount of pesticides that has been used on the crops for this purpose during the SAP period has been researched on this study. The fate of pesticide species inenvironmentthat were used at maximum amount on the large fields and the effect of pesticide residues in environment have been also investigated. The solutions to prevent the pesticide contamination in environment have been submitted in the research. To educate the farmers and the conscious pesticide application, to research the natural products and to support the studying on this research were the priority solutions on the conclusion (Atasoy A. D, 2008).

The report of GAIN (global agriculture information network) had been done researched, in 2008, there was a problem Russia banned imports of certain Turkish fresh fruit and vegetable products, including fresh tomatoes (USDA, 2009) Russian officials stated that the ban was instituted because of continued detections of high levels of pesticide residues on Turkish products since the beginning of 2008 (USDA, 2009).

University of Zaragoza had been done researched on Pesticide residues in field-sprayed and processed fruits and vegetables. This study was initiated to determine what residues of six insecticides (organochlorine, organophosphorus and pyrethroids) and four dithiocarbamate fungicides remained on raw agricultural commodities after harvest and to study the effect of the subsequent commercial processing on the residues. Sprayed crops of tomatoes, red peppers, asparagus, spinach, artichokes and peaches harvested after controlled field trials contained residues well below the maximum residue levels, except for lindane in tomatoes and acephate in artichoke. Commercial processing procedures led to large reductions in residue levels in the finished products. Washing removed all residual lindane, chlorpyrifos and cypermethrin from tomatoes. Chlorpyrifos residues were reduced by 67% during wood-fire roasting of peppers, and subsequent peeling removed all the remains. Peeling and blanching of asparagus reduced chlorpyrifos concentrations to undetectable levels. Processing of artichokes eliminated acephate and chlorpyrifos after blanching. Acephate in peaches survived successive processing steps until the final heat process that destroyed remaining residues. The net results can contribute to assure the consumer of a safe wholesome food supply (Jesus Chavarri, M, et al, 2004).

University of Reims (in France) had been done researched on disappearance of Chlorpyrifos Ethyl Pesticide Residues on Tomatoes, Citrus Fruits and Sugar

Beet Grown in the open Field. This study, the prevalence of chlorpyrifos ethyl in tomatoes, citrus fruit and sugar beet produced in an area of Northern Morocco (Berkane) was investigated. Samples were taken from the major production areas during 2005–2006. Another objective of this work was to evaluate the degradation behaviour and residue Levels of chlorpyrifos ethyl in tomatoes, citrus fruits, and sugar beet grown in open fields under the typical climatic and growing conditions of Berkane. Analysis was carried out using gas chromatography with a nitrogen/phosphorus detector (GC-NPD) after extraction of samples with dichloromethane and clean-up using a florisil column. It was found that residue levels of chlorpyrifos ethyl ranged from 0. 011 to 0. 403 mg/kg for oranges, 0. 004 to 0. 405 mg/kg for tomatoes and 0. 003 to 0. 097 mg/kg for sugar beet. Most of the residue values obtained were far below the values imposed by European Union (EU) legislation (R. Salghi, H. Zerouali, et al, 2008). Only three samples contained chlorpyrifos ethyl levels that exceeded the recommended maximum limit in oranges for most of the EU markets.

The decline behaviour of chlorpyrifos residues in oranges can be described as a pseudo-first order reaction. Residue levels and decline rates of chlorpyrifos ethyl in tomatoes, oranges and sugar beet sprayed with Dursban after the treatment were higher than the maximum residue limit established by the EU; the only exception was after pre-harvest intervals (PHI) of 21 days (tomatoes), 52 days (oranges) and 14 days (sugar beet). Half-life periods (t1/2) were calculated for sugar beet (2 days), oranges (21 days) and tomatoes (8 days) (R. Salghi, H. Zerouali, et al, 2008).

EU Impact Analysis studies of Agricultural Economics Research Institute have done research about the Turkish tomato sector analysis which shows the production of tomatoes, the advantages and disadvantages, fresh tomatoes production between 2000 and 2009, loss production of tomatoes from 2000 to 2007, strength and weakness of horticulture sector in Turkey. The website was useful for the introduction to explain Turkish tomato sector.

Another researched had been done by University of Florida on a descriptive and comparative analysis of pesticide residues in Florida tomatoes and strawberries. The purpose of this study was to demonstrate how the types and levels of pesticide residues can differ between strawberries and tomatoes grown in Florida and how these differences may be associated with production and handling characteristics of each industry (Thomas J. Stevens, et al, 1999). The findings from this analysis can lead to a better understanding of some of the unique pesticide problems associated with a particular commodity.

This could be useful for industry and government decision-makers and advisors. Data on the levels of 19 different pesticide residues found in Florida tomatoes and strawberries are matched to firm and decision-maker attributes as well as fundamental production practices. Descriptive statistics on these residues and the socio-demographic characteristics of the growers, packers, and distributors sampled by this study are presented. Descriptive statistics for strawberries and tomatoes at different market stages are also tested for significant differences. Fundamental differences in production and handling practices for each commodity are discussed and associated with residues. Topical as well as methodological recommendations are provided for future research, extension, and policy directives (Thomas J. Stevens, et al, 1999).

There is a real an issue about the virus of Tomato yellow leaf curl. TYLC is one of the most devastating viral diseases of cultivated tomato (Lycopersicon esculentum) in tropical and subtropical regions worldwide, and losses of up to 100% are frequent. In many regions, TYLC is the main limiting factor in tomato production. The causal agents are a group of geminivirus species belonging to the genus Begomovirus of the family Geminiviridae, all of them named Tomato yellow leaf curl virus (TYLCV) (sensu lato). There has been almost 40 years of research on TYLCV epidemics and intensive research programmes have been conducted to find solutions to the severe problem caused by these viruses. This paper provides an overview of the most outstanding achievements in the research on the TYLCV complex that could lead to more effective control strategies (Moriones, E et al, 2000).

There is other research had been done by university of Mustafa Kemal on Incidence and Insect Transmission of Tomato Yellow Leaf Curl Virus in Hatay Province of Turkey. Tomato yellow leaf curl virus (TYLCV) is one of the most common viruses infecting tomatoes in the Mediterranean region. Tomato samples with typical viral symptoms were collected from tomatoes grown in the open field and greenhouses in 2002-2003 in Hatay province. These samples were tested for TYLCV, CMV, PVX, PVY and PLRV by DAS-ELISA. TYLCV was detected in 18-49% and 13-32% of the field-collected samples for the different districts for 2002-2003, respectively. For the samples collected in the greenhouse, TYLCV infection rates varied from 10-27% and 6-16 for the Samandag district in 2002-2003, respectively.

Tomatoes that tested positive for TYLCV exhibited severe stunting, chlorotic leaf edges, upward leaf cupping, and reduced leaf size. TYLCV-infected tomatoes were observed in tomato transplants in January, when mature tomato plants and whiteflies were present. Bemisia tabaci adults collected from natural infected tomatoes were able to transmit TYLCV to tomato seedlings. Growers should adopt integrated pest management strategies for control of TYLCV infections and should evaluate current moderately resistant hybrids (Sertkaya, G, Acta-hort, 2005).

University of Khon Kaen had been done researched on management blossom end rot disorder of tomatoes in Thailand. Efficacy of calcium silicate, chemical fertilizers, calcium chloride, soil amendment with filter cake, chicken manure, and in combination with each other on the development of blossom-end rot disorder in tomatoes was investigated (Bolkan, H, Acta-hort, 2005). Tomato seeds were sown in peat substrate media with or without calcium silicate. Seedlings were transplanted at 25 days old to different growing media with different soil mixtures and basal fertilizer application. Spraying calcium chloride at anthesis stage had no effect on yield or blossom-end rot development compared to untreated control. Application of chemical fertilizer of 13-13-21 in nitrate form did not promote better yields, but significantly reduced blossom-end rot disorder. Similarly, tomato plants grown without calcium silicate in media supplemented with fermented waste of sugar manufacturing or filter cake; plus chicken manure and half of the recommended amount of 13-13-21 in ammonium form for basal fertilizer + half of the recommended amount of 13-13-21 in ammonium form for top-dressing, and in a treatment same as the above plus foliar sprays of calcium chloride gave better plant growth, high fresh yield (> 4 kg/plant) and low blossom-end rot disorder (<0. 2 fruit/plant) (Bolkan, H, Acta-hort, 2005).

TURKSTAT (Turkish statistical institute) can explain how many tonnes of tomatoes the leading countries export in 2009. This website can show the main tomato customer of Turkey.

Faostat (Food and agriculture organization of the united nations) shows the countries, which grow the most tomatoes in the world in 2009 and total production of tomatoes in Turkey between 1990 and 2009.

3. Materials and method

The experiment was set up to grow tomatoes in open field. The field is in North Turkey province; Nicea and the field was 2000 m? which is a rectangle shape. Before to set up the experiment, the field was designed by using the ANOVA system which is divided the fields into 4 sections (A, B, C, D). ANOVA is statistical method that stands for analysis of variance and when the study involves 3 or more levels of a single independent variable (Statistical consultant, 2010). The aim of the design was to plant the seedlings by using the whole 2000 m? because different areas of the field can provide different conditions for the tomato growth (Appendix 1). There can be different soil conditions and nutrient levels consequently this design is more reliable and give more advantages. As mentioned, there are 4 sections (A, B, C, D) and each section had 3 different treatments which are treatments (1, 2, 3).

Treatment 1 was sprayed insecticide once every week.

Treatment 2 sprayed insecticide every 2 weeks.

Treatment 3 sprayed insecticide every 3 weeks.

There were some space 3 metres between each treatment because whey the spray to the crop, the wind can affect another experiment (Appendix 1). In addition during the growth of the tomatoes, they were sprayed with fungicides and herbicides to control weeds and add the nutrient supply when it was required the insecticide variable remained the same according to the project design.

2 kg example of soil was taken from the field randomly and sent to soil laboratory which is showed that what nutrients, soil ph and organisms are already in the soil therefore this test can help to use nutrients and fertiliser accordingly (Appendix 5). In this experiment, the variety of tomato was `Swanson` F1 hybrid which is from Holland and called De Ruiter Seeds Company. Generally In the region, `Swanson` F1 is recommended which has a high resistance from pest and disease. In the open field, the variety is a significant factor because pest and disease can spread easily particularly with warmer climate therefore the variety should be a high resistance. F1 hybrid seed was chosen because F1 hybrids; produce highly uniform plants, give vigorous seedlings which are easy for crop establishment in the field and give high quality produce (Fresh plaza, 2007).

The planting was done directly to the rows which was planted 40 seedlings in each rows and between the seedlings distance was 40 cm. In totally 2880 seedlings were planted in the 72 rows.

Drip-irrigation system was used for the experiment which is recommended for the open field. At beginning of the field there was pump system all the fertilizer, liquid nutrients was given by the pump and the field water came from about 30 meters above ground (Appendix 3). In the experiment sticky trap left for a week on each treatment to see what insects were in the plant and which treatment got the high level of insect.

Furthermore when the plants height was about 30-40 cm, the plants couldn't stay upright which was required bamboo stake to be upright. Each bamboo was putting in 4 plant and the stems were tied with rope and top of the plant with plastic. During the production, the plants were done pruning every 3 weeks which could reduce the competition between two strong leaves. Furthermore during the production the temperature record was done on each day to see the difference between each month (Appendix 4).

Table 3 shows that during the production which active ingredients were sprayed and their dose) (Appendix 3) Note; red writing an active ingredient was banned in the Europe but still using in Turkey.

Group

Active ingredients

Dose

Insecticides

Chlorpyrifos

Acetamipirid

Lambda-cyhalothrin

Monocrotophos

Deltamethrin

Emamectin benzoate

150gr/ha

30gr/da

50gr/da

100lt water/100gr

60gr/da

30gr/100lt water

Fungicides

Propamocarb

Metalaxly

72% Mancozeb

Liquid Copper (Cu)

Famoxadone and Cymoxanil

Fenarimol

Fosetyl

4ml/m?

500gr/da

50gr/da

200ml/da

50gr/da

10gr/100lt water

200gr/100lt

Acaricides

Clofentezine

Propargite

60ml/da

75ml/100lt water

Herbicides

Metribuzin

60gr/da

(Source; own author`s)

The experiment of spraying started on 10/06/10 until 11/09/10 and this table shows what types of pesticide were used and their active ingredients and their dose. It had been used the same dose for every spray and this experiment pest and disease were controlled by the chemical control (Appendix 3).

In this experiment, harvesting was done 6 different times and each time was picked the crop different amounts which were depending on the crop stage. In harvesting process the plants were picked by hand with labours. Then the crop was picked randomly from each section about 2 kg and put in different plastic bag then sent to the labarotry to analyse them which mrl got

4. Pest and Disease problem from the field

There were number of pest and disease during the production of the plant and mostly occur every year in the region which can reduce the production of the yield. Generally in outdoor production is more risk than glass-house which is possible to control temperature, humidity and air circulation. In contrast, in outdoor production almost don’t have any possibility to control these environmental factors and that’s why most pest and disease can be seen in outdoor production.

4. 1 Leaf mold

Leaf mold had been seen in the field during the production. Leaf mold is a fungal disease which is caused by the fungus Cladosporium fulvum. It can affect the foliage of tomatoes under humid conditions. Mostly in Europe can be seen in green-houses and also can be seen in Mediterranean countries the production of open field. When humidity is high, the fungus can develop rapidly on the leaves, starting on the lower leaves and processing upward.

If the disease is not controlled, large part of the leaves can be killed, resulting in significant yield reductions (Appendix 3). That disease can be controlled by chemical which is recommended to use copper to the crop (University of Illinois, 1989).

4. 2Tomato Yellow Leaf Curl Virus (TYLCV)

TYLCV has become a major problem for tomato growers over recent years in the region and this virus occurs every year which is a significant problem for the tomato growers. The disease was first identified in Israel in 1940. Generally TYLCV can be seen in theMediterranean climate. In 2002 it had been reported that up to 60% of the open field tomato crop in Turkey had been destroyed (Aybak, H et al 2004).

When young tomato plants are infected, they become severely stunted and produce small, distorted leaves which are usually puckered. Leaves that develop soon after infection curl downwards at the margins. Leaves produced later curl upwards and are markedly chlorotic and deformed (Appendix 3).

The infected plants produce no marketable fruit and when older tomato plants are infected, they produce abnormal growth above the point of infection. Any fruit already on the plant ripens almost normally, but flowers often drop or fail to set fruit (FERA, 2000). Early identification of TYLCV symptoms will help remove them before they become a source of infection for the entire crop.

Pull infected plants out as soon as possible, place them in plastic bag, tie the bag shut to prevent the spread of any whiteflies to other plants, and discard properly (Hazera, 2005). The virus is not seed-borne. It is only transmitted by the whitefly, Bemisia tabaci, which is commonly found in tropical and sub-tropical regions, and in temperate areas. The whitefly vector has a very wide host range and feeds by sucking plant juices from the underside of leaves of crops such as tomato, tobacco, cucumber, sweet potato, as well as some weeds (AVDC, 2004). Adult whiteflies look like tiny white moths, about 1–2 mm in length. They fly when the leaf is disturbed. The light-colour eggs are laid on the leaf under surface and hatch in about 16 to 38 days depending upon environmental conditions (AVDC, 2004).

The whitefly can acquire the virus after feeding on infected plants for 15 to 30 minutes, and can transmit the virus to tomato plants after about 24 hours of incubation within the insect. A period of at least 15 minutes feeding on the new tomato host is subsequently required for transmission of the virus. The whitefly retains the virus for up to 20 days and does not transmit it to its progeny (AVDC, 2004). Symptoms develop on young plants after 10 to 14 days. Hot and dry conditions favour the whitefly, and therefore, help the spread of TYLCV. White fly populations decrease after heavy rain showers. Under normal conditions whiteflies hover above the crop during the day or they are passively wind-driven over long distances. During the night they settle on the lower leaf surfaces (AVDC, 2004).

To control of TYLC can be with chemical but before that, Symptomatic plants should immediately be carefully removed, bagged, and discarded to prevent the spread of whiteflies on them that may be carrying the virus. There is applying insecticides to reduce the spread of TYLC which is Imidacloprid-based systemic insecticides (Melzer, J. M. et al, 2009). However chemical control cannot be effective in areas where disease incidence is high.

There are possible ICM options available if feasible such as a boarder crop of maize around the tomato crop or planting a bait crop within the tomatoes can help to reduce the pest within the crop. Pesticide resistance should also be avoided by alternating insecticides. Planting pest resistance varieties can help to reduce and prevent the problem although if the plants are succumbed tostressthen the resistance can be removed.

4. 3Blossom end rot (Calcium deficiency)

Another significant problem was Blossom-end rot in the field which made un-marketable the crop and it occurs almost every year. Blossom end rot is a physiological problem, caused by adverse growing conditions rather than a pest or disease. Certain vegetables that form large fruits, such as aubergines, peppers and (most often) tomatoes are particularly susceptible (RHS, 2011).

The early symptoms, which often go unnoticed, appear as water-soaked lesions on the blossom end or bottom of the fruit (Appendix 3). The affected tissue breaks down and the area becomes sunken, dark brown or black, and leathery which can happen at any stage during fruit development (Howell, J, 2005).

Blossom-end rot is not caused by a parasitic organism but is a physiologic disorder associated with a low concentration of calcium in the fruit. Calcium is required in relatively large concentrations for normal cell growth. When a rapidly growing fruit is deprived of necessary calcium, the tissues break down, leaving the characteristic dry, sunken lesion at the blossom end. Blossom-end rot is induced when demand for calcium exceeds supply. This may result from low calcium levels or high amounts of competitive cations in the soil, drought stress, or excessive soil moisture fluctuations which reduce uptake and movement of calcium into the plant, or rapid, vegetative growth due to excessive nitrogen fertilization (Garden advice, 2008).

Blossom-end rot can be reduced by;

Maintain the soil pH around 6. 5. Liming will supply calcium and will increase the ratio of calcium ions to other competitive ions in the soil.
When side-dressing nitrogen, avoid using ammonium which can interfere with calcium uptake. Urea converts to ammonium and should be avoided as well. Nitrate forms do not interfere with calcium uptake. Calcium nitrate supplies a small amount of calcium as well as nitrogen.
Maintain adequate soil moisture levels uniformly during the growing season.

Be careful to avoid wet dry cycles.

Use mulches to conserve moisture and reduce moisture stress.

Foliar applications of calcium chloride are of little value because most of the calcium is absorbed by the leaves and stays there. Only that which is absorbed through the fruit epidermis will be of value. Growing fruit needs a constant supply of calcium, which would require frequent applications (Howell, J, 2005).

4. 4Late blight (Phytophthora infestans)

Late blight had been seen last 4-5 years in outdoor production in the region which became a serious problem for the tomato growers. In the experiment, during the harvesting had been seen and made the fruit un-marketable. Late blight, caused by the fungus Phytophthora infestans, rarely occurs in Iowa but can devastate tomato plantings during periods of cool, rainy weather. Generally late blight may infect either young (upper) or old (lower) leaves (Gleason, M. L, et al 2005). It first appears as water-soaked areas that enlarge rapidly, forming irregular, greenish black blotches, giving the plant a frost-damaged appearance (Appendix 3). Also infection of green or ripe fruit produces large, irregularly shaped brown blotches and infected fruits rapidly deteriorate into foul-smelling masses (Gleason, M. L, et al 2005).

Late blight is a common disease of tomato crops grown in the tropical highlands and temperate regions. Extended periods of leaf wetness from frequent rain or dew formation, and cool to moderate temperatures (for example, 13–20 °C) are required (AVDRC, 2005). Late blight usually appears in mid- or late August and during the experiment, the rain had been in august after the high temperature.

There are some recommendations to prevent late blight from the crop; First step can be immediately remove and destroy late blight plants from the field. Reduce leaf wetness by staking tomatoes and using drip irrigation. If drip irrigation is not available, reduce the number of furrow irrigations to a minimum or use sprinkler irrigation in the morning or midday to prevent the foliage from being wet overnight (AVDRC, 2005).

Avoid over fertilization of nitrogen. Furthermore apply fungicides as soon as possible at the early stage of the disease especially systemic fungicides. In addition the varieties should be less susceptible to late blight disease because with a high resistance varieties are not possible to have those kinds of disease which can reduce the yield production.

5. Results

This part of the study shows tables and graphs from each different treatment results and comparison with the EU and Russian maximum residues level which have a different residue level. The figure 6 and table 4 shows treatment 1 results and the research found that chlorpyrifos-ethyl level is 0. 012 mg/kg which is higher residue level than the Russian residues level which is 0. 005 mg/kg and this can be real issue and risk for the product exporter. In contrast, for the experiment results chlorpyrifos-ethyl is acceptable for the EU residues level.

Figure 6 shows that the result for treatment 1 from the experiment and comparison with the EU and Russian maximum residues level

Table 4 shows that treatment 1 MRL result and the EU MRL, Russian MRL

Active ingredients

Test result MRL

The EU MRL

Russian MRL

Acetamipirid

0. 032

0. 1

0. 3

Carbendazim

0. 022

0. 5

0. 05

Chlorpyrifos

0. 012

0. 5

0. 005

Clofentezine

0. 48

0. 3

0. 2

Famoxadone

0. 064

1

0. 2

(Food control and central research institute, 2010)

In addition Carbendazim active ingredient can make alarm for the Russian residues level because the figure 6 shows that from the experiment result Carbendazim residue level is 0. 022 mg/kg which is slightly close to the Russian residues level which is 0. 05 mg/kg. Another alarm can be Acetamipirid for the EU residues level in the figure 6 from the experiment Acetamipirid active ingredient level is 0. 032 which is slightly close to the EU residues level which is 0. 1 mg/kg. The figure 6 shows that form the experiment Famoxadone and Clofentezine active ingredient levels are acceptable for the EU and the Russian residues level.

Figure 7 shows that the result for treatment 2 from the experiment and comparison with the EU and Russian maximum residues level

(Food control and central research institute, 2010)

The figure 7 and table 5 shows that for the treatment 2, the research did not find significant issues for insecticide active ingredients compare to the treatment 1 got high level of insecticide active ingredient. Carbendazim active ingredients residues level is 0. 016mg/kg for the experiment which is close to the Russian residues level which is 0. 05 mg/kg maybe that can be alarm for the Russian residue levels.

Table 5 shows that treatment 2 the experiment MRL result and the EU MRL, Russian MRL

Active ingredients

Test result MRL

The EU MRL

Russian MRL

Carbendazim

0. 016

0. 5

0. 05

Clofentezine

0. 094

0. 3

0. 2

Famoxadone

0. 038

1

0. 2

(Food control and central research institute, 2010)

The figure 7 shows that Clofentezine and Famoxadone residues level are acceptable for the EU and the Russian residues levels. Comparison for the treatment 2 results, Carbendazim residues level is 0. 016 mg/kg is higher than the treatment 1 results Carbendazim residues level which is 0. 022 mg/kg. In addition for the treatment 2, Famoxadone active ingredients had a less residue level than the treatment 1.

Figure 8 shows that the result for treatment 3 from the experiment and comparison with the EU and Russian maximum residues level

The figure 8 and table 6 shows that the research found little bit alarm for the treatment 3 but in the figure both active ingredients level are acceptable for the EU and the Russian maximum residue level. Only Acetamipirid active ingredient shows that close to the EU maximum residue level. For the treatment 3 results, the level of Acetamipirid is 0. 026 mg/kg and the EU maximum residue level is 0. 1 mg/kg maybe that can be alarm for the product exporter. In contrast, the treatment 3 Acetamipirid residue level is less than the treatment 1 Acetamipirid level which is 0. 032 mg/kg.

Table 6 shows treatment 3 the experiment MRL result and the EU MRL, Russian MRL

Active ingredients

Test result MRL

The EU MRL

Russian MRL

Acetamipirid

0. 026

0. 1

0. 3

Famoxadone

0. 077

1

0. 2

(Food control and central research institute, 2010)

6. Discussion

Today's modern agriculture produces plentiful food, at a reasonable price, all year round. Consumers can buy whatever and whenever food they want. Consumers rightly expect food to be safe and nutritious and also have become used to food, particularly fruit and vegetables, not having any blemishes or other marks (HSE, 2007). Consumers don't tend to think about how farmers produce food or how it gets from the farm to the shops in perfect condition. Over the last 60 years farmers and growers have changed the way they produce food in order to meet the expectations of consumers, supermarkets and governments. In doing so they have made many changes to the way they farm. This often includes the use of pesticides (HSE, 2007).

Farmers use pesticides to:

Protect crops from insect pests, weeds and fungal diseases while they are growing.

To prevent rats, mice, flies and other insects from contaminating foods whilst they are being stored.

Safeguard human health, by stopping food crops being contaminated by fungi (HSE, 2007).

On the other hand, growers must beware of maximum residues level on the crops for the consumer namely the amounts of residues found in food must be safe for consumers and must be as low as possible. This part of the study will discuss the experiment result comparison with the EU and Russian maximum residues level. As the graphs show that Russian MRL is stricter than the EU MRL because in the past, Russian consumer had been seen lots of problem about high residue level from developing countries such as Turkey and Egypt. Then the government did not take more risk and reduced level of residues on fresh and vegetable products therefore in 2011 Russian became extremely strict country about MRL which make difficult to trade with Russian supermarket but also that can make healthy crop production.

According to new Russian rules, during fresh fruit trade the government send workers to Turkey which they analyse crops before to export, the idea is to see high or low residue level namely they analyse in Turkey (Aybak, H et al 2004). In contrast, Russian government used to analyse crops in bordering gate which can take a week and can reduce crop post-harvest life. Furthermore if exporting tomatoes to Russia, for example, documentation would need to show which plant protection products were used and the time of last application on the crop label.

The research had not found exactly what is expected but still there are some significant issue namely the figure 6 shows high level residues which is chlorpyrifos-ethyl therefore for that active gradient is impossible to sell Russian markets. In addition if exporter trade with treatment 1 crops to Russian wholesaler, they could again bane the Turkish vegetables same as in 2008. Another significant issue is from treatment 1 tomatoes sold to wholesaler in Turkey which is again that active ingredient level higher than Turkish residues level and the problem don`t check crops as the Russian or the EU countries.

The graphs show that the best result was given by treatment 2 and 3. Surprisingly the treatment 3 which sprayed insecticide every 3 weeks got acetamipirid active ingredients 0. 026 mg/kg compare to the treatment 2 results show that did not have any insecticide active ingredient only show fungicides and acaricides residue level. The reason can be wind drift namely the treatment 3 and 1 had 3 meters space which could not be enough. During the experiment the spray was done in the late afternoon which was less wind but it`s possible to drift acetamipirid active ingredient from the treatment 1 to 3. As mentioned the treatment 1 crop could not sell to Russian market on the other hand, treatment 2 and 3 could sell to Russian and the EU markets. In contrast the EU maximum residues level is not necessarily to all supermarkets because supermarkets may find the EU MRL is not strict. For example Mark-Spencer and Waitrose require much lower than the EU MRL. The treatment 1 acetamipirid active ingredients is 0. 032 mg/kg and the EU residue level the same active ingredient is 0, 1 mg/kg therefore these supermarkets would not take risk to sell the tomatoes from the treatment 1. The growers should focus on the EU residue level and supermarkets residue level requirement.

The Turkish government has an aim to reduce the use of pesticide in 2011. Every growers have to have an agriculture advisor which means when the crop have problems, growers have to ask their advisor then control measures can be taken, therefore with this system growers will be more careful to use pesticide and reduce the use, which can help to make a healthier production development, then export may become much easier than the past also growers don't need to pay the agriculture advisor because the government will pay the advisor for growers which is free knowledge from the agriculture advisor (tumgazateler, 2009). The government will spend about 38 million$ (dollars) for this system (tumgazateler, 2009).

Monocrotophos could be significant issue for the experiment which is an organophosphorothioate used in agriculture to control a range of insect pests in a range of horticultural and agricultural crops. Monocrotophos was selected for review by the NRA (National registration authority) board after scoring highly against the agreed selection criteria for public health, occupational health and safety, and environment (NRA, 2000).

In summary, the concerns over the chemical were;

It's very high toxicity to bees.

Its association with worker poisonings overseas, during end use and upon re-entry.

High worker exposure scenarios.

High potential acute and chronic risk (NRA, 2000).

The graphs did not shows Monocrotophos active ingredient residues level on any treatment but this active ingredient was sprayed during the experiment. Therefore the active ingredients still using in Turkey which is extremely harmful for the consumer but the active ingredient is banned in European countries in 2003 (Food fairness briefing, 2008). Consequently if Turkish government is not banned monocrotophos active ingredient, there will be more problem in the future for the exporter immediately the government must bane the active ingredients. Another problem can be dose of pesticides for the growers in Turkey. As mentioned, most growers are not educated also using old tradition farm methods therefore it can be possible to use high dose of chemical to crops maybe the growers don't read chemical labels which gives each different crop and what dose to spray. In the experiment was used correct dose namely looked at what recommended on the chemical label which can be important point which dose the growers use for the crops.

In the future, most countries will become stricter than now particularly Germany. The government of Germany decided to be stricter than the EU maximum residues level because of the consumer. 69% of Germans are concerned about pesticide residues on fruit and vegetables. Active substances in pesticides may reach the consumer as residues on foods of plant origin. However, the amount of these residues must be so low that they do not harm consumer health. Statutory maximum levels must be complied with. The official food control bodies of the federal states monitor compliance. For this they need efficient detection methods which BfR tests (Federal Institute for risk assessment, 2008). In first instance only several German companies are setting the more strict limits. However, when looking at the companies, they have shops all over Europe which might spread the scope of their policy (CBI, 2010). Also Austria and to a lesser degree Sweden, the Netherlands, UK and Denmark are involved. It is however expected that these developments will also take place in other European countries as well (CBI, 2010).

7. Conclusion

It can be concluded that the experiment shows several significant points. The most important point that treatment 2 and 3 were used insecticide less than the treatment 1 but after the harvesting all treatments gave the same size and quality. In Turkey most growers think that, if the spray to the crop, it will give better yield and high quality product which is not showed that. In addition, treatment 1 products would not sell to Russia and too much risk for the EU therefore the growers must stop spray to the crop every week otherwise in the future, there will be more problem than currently. Using less insecticide, the crop was grown healthy and safe as well as the crop price was satisfaction for the growers. The experiment shows that the growers have became more interested on the residue levels and also may stop using old tradition methods of production which may start to use Global-GAP.

During the experiment it had been seen serious pest and virus problem in outdoor production of the tomatoes which reduced the production yield and highly cost to control these virus and pest.

Turkey plays an important role for the production of the tomatoes which has advantages and disadvantages. In the future if the growers develop the production techniques, farming method and more careful about MRL, the production would become a better then the growers can be satisfaction. Also Turkish government politics and the EU politics dissolve the problem about to join European Union, the growers can develop quicker and the level of export would be increase.

8. Recommendations to growers

There will be some recommendations from the experiment to growers in Turkey which is aimed to not make the same mistake and may reduce the use of insecticides during the production of tomatoes. This experiment was done in open field which can create to see more pest and disease than glass-house therefore can push to growers to use high level of pesticide especially in developing countries. Generally most insects are affect in warm climate and less air circulation. As mentioned some pest and virus problem in the experiment which could not control by chemical and reduced to production field.

Turkish growers are extremely new about ICM which is Integrated Crop Management. ICM is a cropping strategy in which the growers aim to conserve and enhance the environment while producing safe and wholesome food economically (Food standards agency pesticide residue minimisation, 2006). ICM recognises that profitability is vital to the success and sustainability of any grower business. Integrated Pest Management (IPM) is a part of ICM and involves developing pest control strategies namely recommendation to growers is that growers must use integrated pest management during the production of tomatoes which can reduce plant disease and is a significant program of pest control strategy, decisions and evaluations. In addition IPM can help the environment and crop production as well as which are designed to help producers protect their crops at the same as minimizing input cost.

IPM can be categorized different control; biological which is the conservation or release of natural enemies that attack or feed on pest such as parasitic wasps, pathogens and predators (SARDI, 2009). Chemical control is use of pesticides as a last resort only and favouring those products that conserve natural enemies. Another control method is cultural which is crop rotation; trap cropping, removal or destruction of diseased plants. Lastly mechanical control which is included simple hand-picking, erecting insect barriers, using traps, vacuuming and tillage to disrupt breeding (SARDI, 2009).

Biological control can recommend to Turkish tomato growers to reduce use of pesticides in the future. Generally this control is not hazardous to the grower, the consumer or the environment. In addition, growers learn the importance to no longer spray according to the seasonal growth calendar (SARDI, 2009).

Biological control helps to reduce pesticide use and to restore the balance of nature. To effectively control pest with biological control, the growers learn about the identification of natural enemies as well as the conservation of natural enemies (SARDI, 2009). Therefore if the Turkish tomato growers use IPM systems, it can reduce pest and disease level, also can reduce use of pesticide which can solve residue level on the crop.

There are some general benefits of IPM:

Promote sound structures and healthy plants.

Reduce problems related to pesticide residue.

Reduce the environmental risk associated with pest management by encouraging the adoption of more ecologically begin control tactics.

Promote the sustainable bio based pest management alternatives.

Reduce the require for pesticides by using several pest management activities.

Maintain the cost-effectiveness of pest management programs (SCC, 2008).

One of the significant recommendations can be changed the all production system namely the growers should not plant tomatoes anymore in open field which can possible to grow in glass-house in the region. There are several advantages of glass-house; possible to use fertilizer more efficient and economical, long season production, easy to control IPM, easy to control environmental factors (temperature, air), high production yield and easy to control weed. However, setting up glass-house is high costly and also heating system are extremely expensive but the growers can get grant from the government. In contrast, if the crop grew in the glass-house, there would be less pest and disease problem which is require less chemical use more biological control therefore the crop would not have high residues level that can increase export.

In the region, most growers think that to grow tomatoes in open field is cheaper which is not. This experiment would not recommend growing the crop in open field because lack of profit. This experiment took about 4 months and 6 time the crop was harvested therefore total inputs of the experiment