INTEGRATED PEST MANAGEMENT PACKAGE ON PROTECTED CROPS

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INTRODUCTION

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The control of root knot nematode is usually based on the use of organo-phosphorous nematocides. The continued use of such products has however been questioned in recent years especially by environmentalists. Residues of pesticides have been detected in vegetables and in the environment where vegetable crops are grown. There is a strong tendency to replace all these wide spectrum pesticides by methods or materials less destructive and deleterious to the environment and to human health.

Great effort have been devoted, especially during the last decades, in all vegetables growing countries of the Mediterranean region, to develop alternative methods for control of root knot nematode by using eco-friendly methods such as soil solarization. These researches were also aimed on including these methods in the packet of IPM together with other cultural practice as a mean to escape from the high infestation of *Meloidogyne spp.* Attempts to control root knot nematode by soil solarization were initiated in Israel, in 1970's. Today this technique is used in more than 50 countries. Solarization also controls other soil-borne organisms such as fungi, insects and weeds. Soil solarization techniques have been developed and tested control tools in Spain, Greece and Italy. Root knot nematodes live in the soil. They are small eel-like worms that feed within the plant root tissue. Female root knot nematodes produce large, rough galls on the roots of infected plants. The plant galls are formed in response to the nematodes' feeding. Plants will often become wilted and stressed under severe infestations. Root knot nematodes live most of their life inside the plant root. It is impossible to observe an individual nematode without a microscope or good quality hand lens. Only their damage can be readily seen with the naked eye.

Most often nematode feeding reduces the flow of water and nutrients into the plant roots, increasing the plant's susceptibility to other stress factors such as heat, water and nutritional deficiencies. The first-stage larvae remain inside their eggs. Only when they reach the second stage do they hatch and start to infest. Once a larva has bored into a root, it moves through the tissues until its head is near the vascular cylinder, preferably close to the root tip. Substances secreted in the saliva during feeding induce the formation of multinucleate giant cells and galls. This cell proliferation destroys the normal tissue structure and leads to severe dysfunction, especially if the vascular cylinder is affected and vessels become blocked or disrupted. The nematodes pass through three further molts before reaching maturity. The adult female breaks through the epidermis and produces a gelatinous egg sac into which it deposits up to 1,000 eggs. M. incognita is parthenogenetic, so males are not necessary for reproduction. After 2-7 days, the second-stage larvae can be found in the soil. The whole life cycle lasts about a month, depending on temperature.

The Integrated Pest Management (IPM) Package

Applied on protected crops, IPM is a strategy of pest control developed in Albania by the Plant Protection Institute, (now Plant Protection Laboratory in Department of Plant Protection in Agricultural University of Tirana), The IPM package gives the possibility to manage the key pest and diseases in tomato crops in greenhouses that causes serious damage reducing the quantity and the quality of this products. Vegetable production in protected areas is a leading industry in Albania that contributes to local economic development and enhances the quality of life of the community. Albania is a traditional exporter of vegetables and pests and diseases are the main constraint to production. In the past, the crops were treated with heavy quantities of broad-spectrum insecticides, fungicides and nematocides that are hazardous to the health and to the environment.

At present, attempts are being made in Albania to reduce the use of chemicals by introducing new approaches, such as the integrated pest control (IPM) practices. In particular, the Plant Protection Institute (PPI), founded in 1971, promoted the adoption of practices that encourage a safe and efficient use of pesticides and support farmers in the implementation of innovative strategies.

The IPM package on protected crops develops sustainable ways to manage the most important pests and diseases in protected areas and helps people to use methods that minimize environmental, health and economic risks. The IPM package consists on an innovative combination of three different methods for controlling the main pests in greenhouses:

- implementation of IPM scouting programs for tomato crop production in greenhouse and

a good specific monitoring system of different pests, that could be easy adapted to different climatic conditions;
- soil solarization, a non- chemical method to control root-knot nematodes (*Meloidogyne spp)* and improve the yield of greenhouse crops;
- integrated fungicidal control programs to maximize economic return on tomato production in Albanian greenhouses and the evaluation of environmental impact;

The IPM Program was managed in Albania by the Plant Protection Institute, in collaboration with the Agriculture University of Tirana, the Pennsylvania State University, the University of California and Virginia Tech. This consortium, through a specific program (Integrated Pest Management Collaborative Research Support Program) was assisting Albanian institutions in their vegetables production and export activities, during years 2006-2009. The consortium is dedicated to the goal of producing high quality of vegetables products by reducing losses due by several pests and diseases, reducing environmental contamination by developing IPM practices in protected crops and increasing quantity and quality of Albanian vegetables products for domestic use and exportation. At the moment, IPM package is implemented in Albania with excellent results in several farms,in Durres,Tirana,Lushnja, Berati and Shkodra regions.

The use of IPM package brings relevant benefits to the environment, as the possibility to reduce the amount of pesticides for crop protection, to reduce the pesticides residues on vegetables products and to augment the beneficial fauna in the vegetables ecosystem. The relevant economic benefit consists in the possibility for farmers to produce vegetables with high quality and introduce it in the national and international market at very advantageous prices.

Economic analyses indicate that using IPM package, Albanian vegetable industry has the potentiality to achieve great benefits. The tomato IPM program in Albania, resulted in net present values of approximately $8 million. Sensitivity analyses were also conducted, and net benefits ranged from $5 to 23 million is calculated over next 30 year if soil solarization is implementing in protected areas for the control of root knot nematode.

The aim of this study was to establish the production efficacy of low, standard and highly intense disease control program on tomato, and produce Environmental Impact Quotient (EIQ) for each disease control program. The introduction of scouting programs, soil solarization and integrated fungicidal control programs as control methods in IPM packages on vegetables crops, have been very successfully and have produced the most satisfying results in terms of level of efficacy, reducing crop loses, increasing farmer income, reducing pesticide use and reducing pesticides residues on vegetables products.

At the moment, the monitoring of pest and diseases in protected crops and implementation of IPM Package in Albania is carried out by the research institutions. The IPM technology for the vegetables production is being transferred to farmers through a variety of routes. In cooperation with MoAF (Directory of Science and Extension Service of the Albanian Ministry of Agriculture), regional workshops have been conducted in various sections of the main region of vegetables cultivation (Durres, Lushnje, Elbasan, Tirane, Berat, etc.). Presentations on the management of vegetables pests and diseases were made by the IPM CRSP project and participants (inspectors, Albanian vegetables growers, farm advisers) were provided extension materials. In cooperation with Albanian Agriculture Farmer's Federation, and with other USAID projects, several workshops and demonstrations were conducted to facilitate the understanding of IPM tactics in protected areas and to improve the control of root knot nematodes in the main region of vegetables production.

WHAT PROBLEM DOES IT SOLVE

Implementation of IPM scouting programs for tomato crop production in greenhouse

Current grower practice emphasizes prophylactic calendar sprays for control of pests and diseases, resulting in high pesticides input. This results in high labor and material costs, minimizes the potential for integrating other management tactics, and creates environmental, health and export constraints. Pesticides currently used against tomato pests and diseases fail to give effective control, possibly because of the lack of resistant management protocols for pesticide use.

IPM seeks to minimize pesticide use in production systems therefore effective new elements of IPM programs need to be included and adopted to this cropping system to reduce the use chemicals. Farmer empowerment through education and transfer of technology will ensure the successful implementation of new methods of crop (pest) management. Great effort have been devoted, especially during the last decades, in all vegetables growing countries of the Mediterranean region, to develop alternative methods for monitoring of pests and diseases using for example of color traps, weekly scouting etc. These researches

were also aimed on including these methods in the packet of IPM together with other cultural practices as a mean to escape from the high infestation of key pests and diseases.

Soil Solarization, a non-chemical method to control root-knot nematodes (*Meloidogyne spp)* and improve the yield of greenhouse crops

Protected crops are the main source of employment of several thousands of families in Albania. More than 730 ha of greenhouses per year are cultivated with Solanaceous, Cucurbitaceous and other vegetable crops. Production is mostly in the South-Eastern part of Albania where the annual number of sunshine is highest more than 2500 hours per year. Greenhouses usually remain un-cropped during July-August and very often nematode are the major soil borne pathogens.

During the years 2007-2009 several experiments were conducted to compare the effectiveness of soil solarization in different soil types and yield increases. Among the most damaging pests in vegetables cultivated in protected areas is the root-knot nematode (*Meloidogyne incognita*). Root-knot nematode (RKN) has a very wide host range, which includes all vegetables commonly grown in protected areas. The nematode typically becomes a problem in sandy soils, especially during summer and fall when temperatures are high. It is probably the most widespread and economically important of all nematode pests and in areas where root-knot nematode is not controlled, its damage has been responsible for losses up to 50% of tomato production. In some varieties of cucumbers, this pest is capable of destroying 100% of the crop.

Integrated fungicidal control programs to maximize economic return on tomato production in Albanian greenhouses

Tomatoes are now Albania's first largest fresh market vegetable. Some producers report that tomato production may now account the most important of a grower's gross income. Important diseases that threaten tomatoes each year are downy mildew (*Phytophtora infestans* Mont de Bary), gray mould (*Botrytis cinerea* Pers), leaf mould (*Cladosporium fulvum* Cke),early blight (*Alternaria solani* Hill) etc. The tomato key diseases may require one to several applications but cost may be high and prohibitive. However, precise reductions in fungicide application and cost savings are yet not known and IPM program can help lower disease control costs and the amount of fungicide entering the environment.

THE IPM PACKAGE, IN PRACTICE

The application of IPM package on protected crops is based on three elements:

- Implementing the best monitoring system for the detection of key pest and diseases
- Selecting the "Soil Solarization" as a eco-friendly method to control rot knot nematode
- Using the integrated fungicidal control programs to maximize economic return on tomato production in greenhouses

Monitoring of pest and diseases

The implementation of an effective Monitoring system is essential in order to find out where the pest and diseases are what are doing, and to evaluate the effectiveness of control measures.

For this reason Scouts have been trained in Lushnja region one of the major vegetable production area in Albania. Test crop examined in greenhouses are tomatoes. By implementing a scouting program we had the intention to demonstrate that such a program could be effective on many vegetable crops in Lushnja region and elsewhere in Albania. One greenhouse is select in Kemishtaj (Lushnja region) for scouting and reporting. Another five greenhouses were selected as control and data on the history and management of pest and diseases were recorded by direct interview with tomato growers. Monitoring methods have included the use of plant samples and sticky traps. The number of plants sampled was depended on size of area of greenhouse, susceptibility of the crop to pests and diseases, and the amount of time involved in monitoring. In general, during the weekly visit, the monitoring is done in ten leaves, inflorescences and fruits from each ten tomato plants

randomly selected. Sticky traps for the monitoring of key pests were used at a minimum rate of 3 per 1000 square meter and a vertical strip equivalent to 20% of the surface area of the card were counted at each monitoring date. Sampling strategies were developed during the initial months of the study to determine the minimum number of plants and traps necessary to obtain sufficient information concerning population trends at a reasonable cost.

Scouts were responsible for keeping detailed records for each operation. At the end of the study, these records have showed:

- how much labor will be involved,
- amounts and choices of pesticides,
- and the quality of crops produced.

This information is used to prepare an economic analysis of the benefits of the IPM program as compared to the growers' conventional pest management strategies.

Soil Solarization

Control of plant parasitic by heat is one of the oldest methods of managing nematode populations. Most nematodes are killed at temperatures above 48^0C. Soil temperatures can be increased by steam, dry heat and soil solarization. While soil sterilization by steam assures complete nematode kill, it may also kill beneficial organisms and alter soil structure. Control of nematodes by dry heat usually involves removing the soil and heating it in an oven to the desired temperature. It requires excessive handling of the soil and may also destroy soil structure. Soil solarization is a simple process whereby heat from the sun is transferred to the soil. Solar heating involves a process of trapping solar energy in the soil by covering the soil surface with polyethylene films. There are several procedures that must be followed closely in order to be effective in increasing the soil temperature to control nematodes by solarization. This technique is tested on several types of greenhouses and in different regions of vegetables cultivation in Albania (Durres, Tirane, Lushnje, Berat, Shkoder etc).

Principles of Soil Solarization

- Use transparent (clear), not black, polyethylene film because it transmits most of the solar radiation directly to soil. Black polyethylene absorbs the heat and does not conduct the heat downward.
- The thinnest polyethylene film available (0,05-0,06mm) is the most effective and economical to use. It must be strong and durable so as to allow for stretching while being placed on the soil.
- Solarization should ideally be done during the summer, July to August, when there are high air temperature and intense solar radiation.
- Soil should be kept damp to increase thermal sensitivity and to improve heat conduction. A single deep irrigation prior treatment may be sufficient, but additional moisture may enhance solarization.
- Longer periods of solarization will greatly improve control particularly at greater depths. Normally 4 to 6 weeks is an adequate period of solarization; however, it is essential to check the soil temperature to determine if temperatures lethal to nematodes are obtained.
- At the end of solarization process, when removing the plastic films it is important not to contaminate the solarized soil with soil that has not been treated. This is also true at planting and best results are obtained when beds are prepared for planting before solarization and immediately planted after removing the plastic films.
- Soil solarization has the characteristics of an integrated control process because physical, chemical, and biological mechanisms may be involved and a variety of pests are controlled.

The adaption of this method is economic as it doesn't require follow-up fieldwork. It is an effective treatment against root knot nematode which does not require the use pesticides therefore not leaving chemical residues on fruits and leaves. The method is respectful of the ecosystem and it produces an adequate environment for the implementation of a biological control program in greenhouses. This method is completely non chemic and complies with the European regulations (2092/91), so it can successfully be used in vegetables organic agriculture cultivation The cost of the "Soil Solarzation" method in Albania was approximately US$ 120-150 per 1000m^2. This method reduces the amount of pesticides used for root knot nematode control by 100%. Considerable reduction of the cost of *Soil Solarization* method is expected when the farmers can remove the plastic films carefully and so the un-damaged plastic film can be used again the next year. In general the chemical treatments are more expensive.

Integrated fungicidal control programs

This research project evaluated the performance of tomato disease control under four different disease control programs ranging from a minimally acceptable to a highly intensive program.

- In the low cost program, spray intervals were at 10 days. This program utilized both organic and inorganic fungicides to control the main diseases.
- The standard program utilized only synthetic organic fungicides. The standard program was also be sprayed on a 10 day interval.

- The intensive fungicide program mirrored the standard program but sprayed on a 5 day schedule.
- In the control the decision for treatments and for the kind of fungicides used were chosen by the farmer.

These four diseases control spray programs were compared on the basis of cost and disease management as well as the environmental impact. These experiments were carried out in Lushnja region (Albania) for the first crop of tomato cultivation. At the end of the season, foliar evaluations were made to determine the percent severity of foliage infected with downy mildew and other prominent diseases. In addition, average fruit weight is recorded. The fungicide spray records of each treatment were reviewed for economic feasibility and environmental impacts. Because most growers are also concerned with environmental impacts associated with their production practices, Environmental Impact Quotients (EIQ) were assessed for each pesticide used in the spray program.

RESULTS

The implementation of IPM Package in Albania previewed that Extension agents and farmers were trained in the application of the "Soil Solarization" method. On farm demonstration trials are used to teach farmers about improved IPM technologies for vegetable insect pest and disease control. Through their participation in the demonstration trials 40 ha of greenhouses were managed as based on IPM CRSP recommendations. As the innovation is based on a three-step methodology, it is important to analyze the results step-by-step.

Implementation of IPM scouting programs for tomato crop production in greenhouse

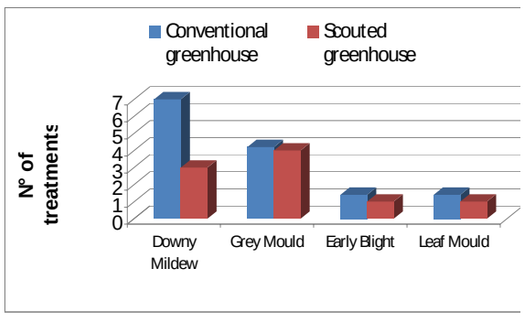

Fig. 1: Number of treatments in conventional and scout Greenhouse (Control of tomato diseases)

Regular monitoring is the framework of good integrated pest management (IPM) programs and must be in place before others control alternatives can be implemented. The backbone of a good IPM program is the scout who looks regularly for pests and plants abnormalities, records what is found, summarizes this information, and reports it to the grower for the final pest management decision. Since so many vegetable crop growers in Albania are still mismanaging pesticides because of the lack of sound monitoring practices, the primary objective of this study was to demonstrate the benefits and economic feasibility of using scouts in IPM programs. Observation done during the scouting program indicated that the monitoring of pests and diseases is an effective tool in timing pesticide applications and minimizing pesticide input.

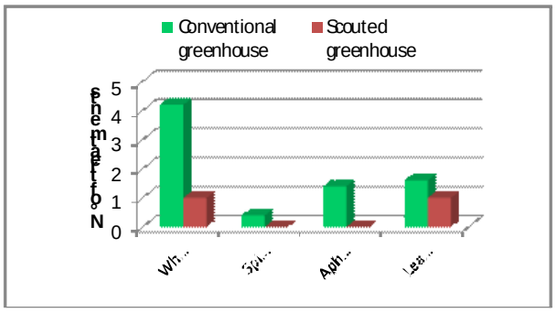

Fig.2 Number of treatments in conventional and scouted greenhouse (Control of tomato pests)

The chemical treatments done for the control of different diseases and insect pests are showed in the Figure 1 and Figure 2. In the conventional greenhouses the number of treatments used per crop cycle is quite variable depending on the type of greenhouses, farmer practice and period of the year. In the case of tomatoes grown under protected cultivation surveys showed that farmer's approaches to chemical control were quite variable.

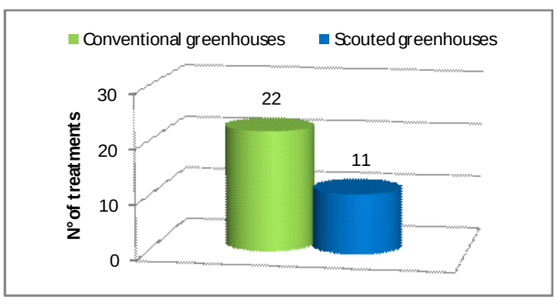

Fig. 3 Number of pesticide sprays per tomato crop cycle (Fungicides+Insecticides)

The number of pesticide sprays per crop cycle varied between 7.6 for insecticides, to 14 for fungicides. In scouted greenhouses these figures are quite different and the number of insecticides and fungicides application is 2 and 9 respectively. In general during the all period of tomato cultivation in conventional greenhouses are done in total about 22 chemical treatments compared with 11 treatments done in scouted greenhouse. (Fig3). The information about the economic analysis of the benefits of IPM scouting program as compared to the grower' conventional pests and diseases management are presented in Fig 4. The economic effect of scouting program is very clear.

The economic analyses indicate that scouting saved 46.6 % of the applied pesticide volume as compared to the non-scouted area, and resulted in overall economic savings of 29, 37 % (or 6967 lek/01/ha = about US$ 650).

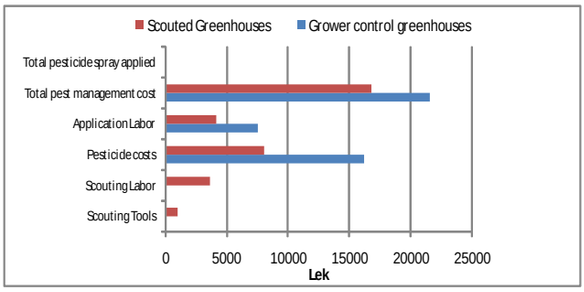

Fig 4 Cost of scouting and conventional program

Tomato and lettuce cultivation in Albania are susceptible to infection by soil-borne diseases and severe yield losses can result especially by rot knot nematode. The effectiveness of solarization, a soil disinfection technique that use passive solar heating, to control the incidence of root knot nematode under greenhouse condition was studied during the second crop of 2007 -2008 in Lushnja and Durres regions. Solarization was accomplished by the application of 0,05-0,06mm clear polyethylene sheets to moist soil for 4-wk during the hot season.

Soil temperature

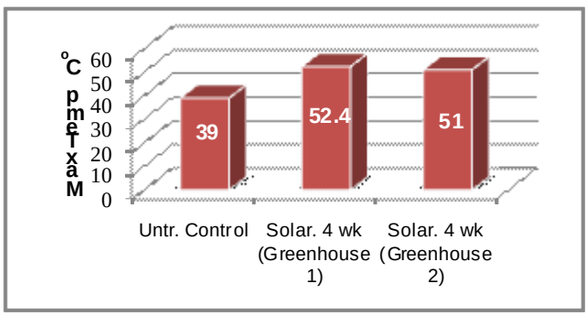

Fig. 5: Maximal temperature during soil solariz

In closed plastic greenhouses the mulching of moistened soil with transparent polyethylene sheets during 4 weeks in July-August, induce an increase of temperature

Maximum soil temperatures achieved under solarization were 51^{0}C in the alluvial soil in Rade-Durres and 52,4^{0}C in the heavy clay soil type in Kemishtaj-Lushnje at depth 20 cm. In the non solarization unheated greenhouse soil temperature achieved 39^0 C (Figure 5).

Effect of soil solarization on the nematode population densities (tomato)

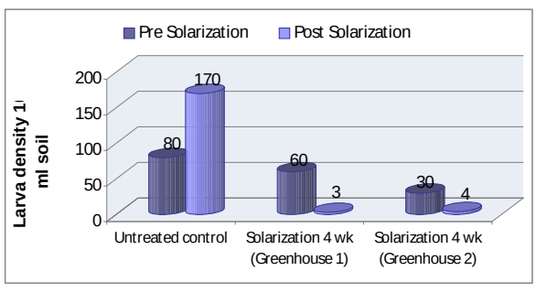

Fig. 6: Effect of soil solarization on the population densities of nematode in soil.

The effect of soil solarization treatments on the population densities of root knot nematode *M.incognita* was very clear. The larva density per 100 ml of soil was markedly reduced compared with the untreated control (Fig. 6). The soil solarization method had a significant influence to reduce the severity of root damage. Root galling index is the most important symptom for the root knot nematode. In Lushnja region this index is dramatically reduced in both solarized greenhouses compared with untreated control where the highest root galling index was found. (Figure 7).

Effects of soil solarization on tomato yield

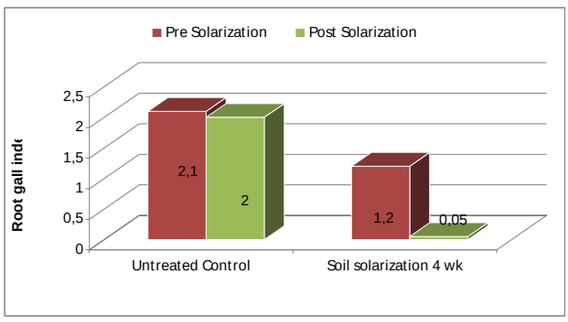

Fig. 7: Effect of soil solarization on root damage of root knot nematode

The grow of tomato plants, as indicated by visual assessment and plant height measurements was significantly improved by the soil solarization. Tomato fruit yields in solarized greenhouses were four fold higher than those obtained in untreated control (Figure 8). Such significant increases were consistent with effective control of nematode provided by solarization.

Solarization is also know to improve plant growth and yield through the release of nutrient induced by high soil temperatures. The soil solarization treatment reduced nematode populations more than 90% also in lettuce. The yield of lettuce was about two fold higher in solarized soil as compared with untreated control in several experimental plots.

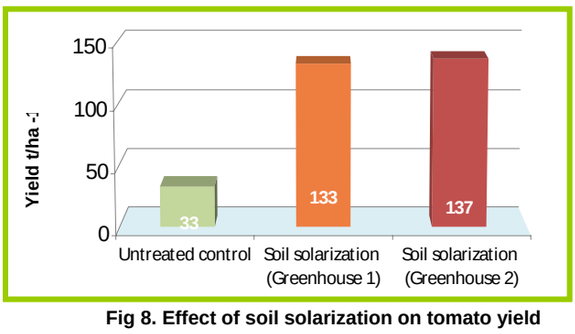

Fig 8. Effect of soil solarization on tomato yield

Soil solarization should be done during the hottest period of the year. Soil solarization offers a satisfactory and environmentally friendly solution for the control of root-knot nematode. This method is easily to be used into organic, conventional and integrated control growing system.

This technique in the same time show good results to reduce the infection of a severe tomato disease like corky root disease (*Pyrenochaeta lycopersici* Schneider&Gerlach).

Integrated fungicidal control programs

The effect of fungicide programs on foliar diseases

Over all fungicide treatment combinations there were some differences on average fruit size between the four spray programs and there were also differences in percent foliar infection for gray mould, downy mildew, leaf mould and early blight observed on tomato leaves. The % of severity of these diseases was significantly higher on the low cost and control treatments compared to the standard and intensive fungicide treatment (Table 1).

	Fruit gr.	Downy mildew rating		Gray mould Rating		Leaf mould rating		Early blight rating	
		Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Low cost	120.6	2,0	8,0	2,0	10,7	5,2	24,6	-	4,83
Standard	151.3	-	1,7	0,3	1,5	-	3,17	-	1,67
Intensive	163.4	-	1,0	-	1,33	-	2,67	-	1,0
Control	114,8	2,33	9,2	2,7	12,3	8,2	27,3	-	5,33

Tab. 1: **The effect of fungicide program on yield and percent infection of main diseases**

Economic costs of spray programs

At the end of the season, the fungicide spray records for each program were reviewed for economic costs and environmental impacts. Fungicide costs were generated from actual retail cost. If two or more compounds were used in a tank mix, the cost of each component was added together and referred to as the segment cost (Table 2).

Fungicide combinations	Segment cost (Leke)	No. of Applications	Segment cost/ season	Program cost /season
Low cost (Dithane + Kocide)	162,0	8	1296,0	1296,0
Standard (Daconil + Acroblu)	294,0	4	1176,0	2448,0
Standard (Equation pro + Teldor)	318,0	4	1272,0	
Intensive (Daconil + Acroblu)	294,0	8	2352,0	4578,0
Intensive (Equation pro + Teldor)	318,0	7	2226,0	
Control (Acrobat)	270,0	3	810,0	1300,8
Control (Bavistine)	75,0	2	150,0	
Control (Acroblu)	114,0	1	114,0	
Control (Daconil)	180,0	1	180,0	
Control (Stoper)	46,8	1	46,8	

Table 2 Composition, cost and frequency of four fungicide program

Environmental impact of spray programs

Aside from fungicide costs, growers are concerned with environmental impacts associated with their production practices, specifically pesticide applications. Environmental Impact Quotients (EIQ) are a scientific means of assessing pesticide fate in the environment based on toxicological and environmental data, impacts against arthropod natural enemies, honey bees, and birds, leaching potential, and related human health issues.EIQ values for fungicides used in this study have already been calculated in the paper by Kovach et al (1992). In general, lower EIQ scores indicate products with overall lower environmental impact. Perhaps what is more important than the raw EIQ score is the Field Use Rating (FUR), which takes into account the EIQ score x % active ingredient x rate per ha to get a more accurate picture of environmental impact. When comparing spray programs it is important to realize that the EIQ FUR score needs to be multiplied by the number of applications made over the season to get an accurate overall understanding of environmental impacts (Table 3).

Fungicide combinations	EIQ FUR	No of applications	Partial Program EIQ	Program EIQ
Low cost (Dithane + Kocide)	55,2	8	441,6	441,6
Standard (Daconil + Acroblu)	103,44	4	413,76	445,92
Standard (Equation pro + Teldor)	8,04	4	32,16	
Intensive (Daconil + Acroblu)	103,44	8	827,52	883,8
Intensive (Equation pro + Teldor)	8,04	7	56,28	
Control (Acrobat)	32,77	3	98,31	233,13
Control (Bavistine)	14,04	2	28,08	
Control (Acroblu)	45,7	1	45,7	
Control (Daconil)	57,744	1	57,744	
Control (Stoper)	3,3	1	3,3	

Tab. 3 Rank of fungicide programs by environmental impact, economic and disease factors

The standard fungicide program remains the best recommendation. It control the main tomato diseases better than the others treatments and had no significant differences with intensive program. However, it was more expensive than control and low cost but cheaper in cost and had the lower environment impact than intensive program.

Practical conclusions

The use of scouting program in the production of tomato crops will facilitate an important change in the way procedures use pesticides. By carefully monitoring/scouting crops and evaluating the information collected, growers will be in a better position to make rational decisions on the appropriate control tactic. The use of scouting program will also reduce and/or eliminate the prophylactic application of pesticides on tomato crops. The proposed scouting program will help growers reduce the total volume of pesticides used, and subsequently decrease the potential for surface and groundwater contamination.

Solarization to control root knot nematode is simple and economic in its application, and leaves no toxic residues for humans, animals and plants. These attributes make solarization suitable for application in a wide variety of production system.Soil solarization should be done during the hottest period of the year. Soil solarization offers a satisfactory and environmentally friendly solution for the control of root-knot nematode. This method is easily to be used into organic, conventional and integrated control growing system and it is more economic as chemical treatments.

The standard fungicide program is the best recommendation. It control the main tomato diseases better than others treatments and had no significant differences with intensive program. It was cheaper in cost and had the lower environment impact than intensive program.

INTERNATIONAL INTEREST

The implementation the IPM package on protected crops to reduce the use of pesticide in vegetables production industry is highly advantageous. The introduction of soil solarization as control methods in IPM packages for root knot nematode control, has been very successfully accomplished on pilot scales in a number of vegetables production countries. These trials are now being extended, into area-wide programs in Spain, Italy, Greece and nowadays a strong interest in IPM package method implementation is registered in the whole Mediterranean basin.

The same situation is also for the implementation of pest and diseases scouting programs and to select the most appropriate integrated fungicidal control programs to maximize economic return on tomato production in greenhouse. The promising results should stimulate further investigations of environment sound methods to control olive root knot nematode and other key pests of protected ares in large-scale trials over a broader geographical range. The IPM package method implementation in Albania is supported by the Albanian mission of the United States Agency for International Development (USAID). To promote the production of tomatoes with high quality and for for export, the Pennsylvania State University, University of California and Virginia Tech, have working collaboratively with the Albanian institutions.

Using IPM Package on protected Crops in other countries

Management of vegetables' pests and diseases on protected areas in a country depends on a combination of early detection of pest, an effective method to control nematode such as soil solarization and finding an appropriate fungicide program to control diseases.

To adopt the IPM Package, a combined interdisciplinary action must be implemented by a consortium of competent Institutions. The institutions that could be involved include: agricultural research institutions, University, specialists or technicians of vegetables culture and extension services. It is important to emphasize the interdisciplinary character of the work team, due to the method's characteristics.

Early detection of vegetables' pests and diseases on protected areas is essential to preventing infestation in commercial production areas. The Ministry of Agriculture should develop a statewide management plan to detect and combat the pests in commercial vegetables growing districts including IPM control programs. The *Soil Solarization* method to control root knot nematode in general is very simple and not requires extensive technological background and a great amount of knowledge to be transfer to the farmers.The necessary technical equipment consists only in plastic sheets 0,06-0,08mm, that are produced by specialized private companies of different Mediterranean Countries and that are easy find in several agricultural shops. Steps for IPM Package implementation:

Making a Consortium with Agricultural Research Institutes and universities. The Consortium will carried on the following activities:

- Identification of potential area of IPM implementation
- Monitoring of key pests
- Controlling the root knot nematode(RKN) through *Soil Solarization* method
- Controlling the key diseases through Integrated fungicidal control programs
- IPM Package designing, based in the previous steps

Transfer of IPM technology to vegetables growers of the selected areas, through the Extension Services of the Regional Administrations:

- Identification of the farmer associations interested in implementing IPM Package
- Theoretical and technical training of the farmers on the different aspects of IPM Package utilization: realization of regional workshops, realization on demonstration trials on improved IPM technologies for vegetables insect pest and disease control, practical training on the application of the “Soil Solarization” method.
- Application of IPM Package, managed with local Vegetables Growers Associations, single Albanian vegetables growers, farm advisers.

TO KNOW MORE

Information is also available on Web:

http://www.ag.vt.edu/ipmcrsp/index.asp

http://www.oired.vt.edu/ipmcrsp/

CONTACTS

The Plant Protection Laboratory of Durres Albania is available to provide technical support and innovation transfer to the interested countries. In order to establish collaborations, contact:

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