# STUDY ON ADOPTION OF INTEGRATED PEST MANAGEMENT (IPM) TECHNOLOGY IN TOMATO *(Lycopersicon esculantum)*

*By*

**MR. SHETE DATTA NARAYAN**
**Reg. No.-04/185**

*A thesis submitted to the*

**MAHATMA PHULE KRISHI VIDYAPEETH,**
**RAHURI-413 722, DIST. : AHMEDNAGAR,**
**MAHARASHTRA (INDIA)**

*In partial fulfillment of the requirements for the Degree of*

**MASTER OF SCIENCE (AGRICULTURE)**

*In*

**AGRICULTURAL EXTENSION**

*Approved By*

Dr. V. J. Tarde
Chairman and Research Guide
Assistant Professor of Agril. Extension
College of Agriculture, Pune-411 005

Dr. D. R. Thorat
Committee Member
Ex-professor of Agril. Extension
College of Agriculture,
Pune-411 005

Dr. G. K. Sasane
Committee Member
Professor of Agril. Extension
College of Agriculture,
Kolhapur-416 004

Dr. S. M. Galande
Committee Member
Assistant Professor of Agril. Entomology
College of Agriculture,
Pune-411 005

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**MR. SHETE DATTA NARAYAN**
**Reg. No.-04/185**

**DEPARTMENT OF EXTENSION EDUCATION**
**COLLEGE OF AGRICULTURE, PUNE- 411 005**
**MAHARASHTRA (INDIA)**
**2006**

# CANDIDATE'S DECLARATION

I hereby declare that the thesis entitled **STUDY ON ADOPTION OF INTEGRATED PEST MANAGEMENT (IPM) TECHNOLOGY IN TOMATO (*Lycopersicon esculantum* Mill.)** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra State in partial fulfillment of the requirement for the award of degree of **MASTER OF SCIENCE (Agriculture)** in **AGRICULTURAL EXTENSION** and that no part of the thesis has been submitted for any other person, to any other university or institute for Degree or Diploma.

Place : Pune
Date : 30.11.2006

**Shete Datta Narayan**

Dr. V. J. Tarde
Assistant Professor of Agricultural Extension
Department of Extension Education
College of Agriculture, Pune-411005
Maharashtra State, India.

# CERTIFICATE

This is to certify that the thesis entitled **STUDY ON ADOPTION OF INTEGRATED PEST MANAGEMENT (IPM) TECHNOLOGY IN TOMATO (*Lycopersicon esculantum* Mill.)** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra State in partial fulfillment of the requirement for the award of degree of **MASTER OF SCIENCE (Agriculture)** in **AGRICULTURAL EXTENSION**, embodies the results of a piece of bonafide research work carried out by **Mr. SHETE DATTA NARAYAN** under my guidance and supervision, and that no part of the thesis has been submitted for any other Degree or Diploma.

The assistance and the help received during the course of this investigation have been acknowledged.

Place : Pune.
Date : 30.11.2006

**(Dr. V. J. Tarde)**
Research Guide

**Dr. R. N. Sabale**
Associate Dean and Principal
College of Agriculture,
Pune – 411005
Maharashtra State, India.

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Place : Pune.
Date : 30.11.2006

**Dr. R. N. Sabale**

# Acknowledgement

*I feel extremely honour for the opportunity stowed upon me to work under guidance of* ***Dr. V. J. Tarde,*** *Research guide. I wish to place on record, my indebtedness for his constant inspiration, well-versed advice, which is reflection of his experience, and fraternity shown by him, through out the progress of this investigation.*

*It is my privilege to record my sincere thanks to Dr. P.G. Khalache, the Head, Department of Extension Education, MPKV, Rahuri. I am extremely thankful to Dr. D. R. Thorat, Ex. Professor & Head Dept. of Extension Education, Dr. G. K. Sasane, Professor & Head , Department of Extension Education, College of Agriculture, Kolhapur and Dr. S. M. Galande, Assistant Professor of Entomology, College of Agriculture, Pune, for their kind co-operation, valuable advice & constructive criticism which helpful for me to overcome my mistakes. I would also like extend my hurtful gratitude to Dr. V. S. Shirke, Professor & Head, Department of Extension Education, College of Agriculture, Pune for his extensive help & valuable suggestions during the course of research work.*

*I also extend my sincere thanks to Dr. G.K. Solanki, Assistant Professor, Smt. S. S. Khandave, Assistant Professor & Dr. A. M. Chavai, JRA, and also teaching & ministerial staff of Dept. of Extension Education, College of Agriculture, Pune for their various kind of help during completion of my research work.*

*I am thankful to the Tomato Growers for their willing co-operation in data collection. I am thankful to Mr. M. N. Atolesaheb, Sub-Divisional Agricultural Officer, Pune., Mr. Balasaheb Pawar & Mr. Rajesh Chavan for his valuable advice & inspirable co-operation to me.*

*I also express personal appreciation to Mrs. Anuradha & Mr. Vasant More & also my senior friends Ashok, Sunil, Pandit, Ramesh, Ramdas, Ankush, Sambhaji, Pant, Fayaj, Devdatta, Sachin , Shubhangi and Arpana for their inspiration and guidance.*

*My heartful thanks to my friends namely Ganesh, Amar, Shirish, Priti, Atul, Pallavi, Arundati, Vilas, Megha, Namdev, Yogesh, Madhavi, Archana, Suvidha, Shivaji, Santosh & Jaywant for their love & co-operation during my degree programme. Also thanks for Deepak, Vamsi, Nitin, Harshad, Kiran, Ranjeet, Vishwash, Amit & Anand for their help during my research work. My sincere thanks to those who have directly, indirectly help me in the course of this investigation & whose name do not appeared in this acknowledgement.*

*It is least but one, I would like to mention 'Chhakuli' who increase my joy and stollen my tirdness with her inocent smile.*

*At the edge of my acknowledgement, I would like to recall all Love, Happiness and sarrows shared in brotherhood with 'Mavali' and all warries carried by 'Aai' and 'Tatya' for our welfare. Being son of a Farmer I have tried to collect all necessary information useful to farmer and if it works,*

*Being introvert for expressing my love against my parents avail this opportunity to express my love, respect for them, still words are not enough for expressing my heartiest gratitude to my beloved parents & younger brother Mavali.*

Place- Pune
Date- 30.11.2007 Datta N. Shete

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# ABSTRACT

## STUDY ON ADOPTION OF INTEGRATED PEST MANAGEMENT (IPM) TECHNOLOGY IN TOMATO (*Lycopersicon esculentum* Mill.)

*by*

**MR. SHETE DATTA NARAYAN**

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**RAHURI 413 722, DIST. AHMEDNAGAR**
**2006**

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|---|---|---|
| **Research Guide** | **:** | **Dr. V. J. Tarde** |
| **Discipline** | **:** | **Agricultural Extension** |

As achieving the goal of higher production with minimum efforts and at reasonable cost we must integrate all the practices of the crop production. The integrated pest management (IPM) technology has proved it self not only for production of good quality but also at a reasonable cost and free from pesticidal residues. The IPM technology for pest control in various crops has assumed special significance now days. Tomato (*Lycopersicon esculentum* Mill.) is one of the most important 'Protective foods'. However it is observed that tomato growers do not adopt IPM technology on large scale. Looking to this fact, the present study entitled '**Study on Adoption of Integrated Pest Management (IPM) Technology in Tomato (*Lycopersicon esculentum* Mill.)'** was undertaken.

**Abstract Contd..... D. N. Shete**

The present study was conducted in Haveli Tahsil having prominent area under tomato in Pune district by selecting 10 villages for study. Total 130 tomato growers were selected as respondents. The study was undertaken with the objectives to study personal, socio-economic characteristics, knowledge level and their extent of adoption of IPM technology, constraints faced by them in adoption of IPM technology and to obtain their suggestion to over come the constraints.

The study revealed that the largest segment of tomato growers are young age group having secondary education, marginal land holding, annual income of Rs. 1,00,001 to 1,50,000, medium social participation, medium use of source of information and having medium knowledge level were adopting the IPM technology of tomato at medium level.

The tomato growers had medium level of overall knowledge about IPM technology. They had medium level of knowledge about cultural, mechanical and biological practices of IPM technology, however they had high level of knowledge about chemical practices.

The overall adoption of IPM technology of tomato by tomato growers was at medium level. Also they had medium adoption level of cultural, mechanical, biological and chemical practices of the IPM technology.

The study revealed that personal and socioeconomic characteristics of the tomato grower's education, annual income, land holding, social participation, sources of information and knowledge were positively and significantly correlated with their level of adoption of IPM technology. The variable age had negative and significant correlation with the adoption level.

The important constraints reported by considerable number of tomato grower were high cost of fertilizers, pesticides, fungicides and bio-pesticides, unavailability of pest and disease resistant improved

varieties, fluctuation in market price, uncontrolled commission rate of middlemen, high interest rate on crop loan, inadequate and timely supply of loans for tomato cultivation.

Availability of bio-pesticides, pheromone traps and light traps at reasonable price and at local place were the important suggestions made by the tomato grower. The other suggestions were plant protection equipment should be available in time at reasonable rate, loan should be available in time, providing the subsidy for IPM and disease and pest forecasting from state Department of Agriculture and State Agricultural Universities.

# 1. Introduction

*'There is no option expect to produce more food and other commodities under conditions of diminishing per capita arable land and irrigation water resources. Hence, we must harnes the best in forntier technologies and integrate them with traditional wisdom and thereby launch an ecotechnology movement.'*

*- Prof. M. S. Swaminathan.*

India acknowledged as gaining economic giant with a growth rate of 8.1 per cent during the year 2005-06 is posted for a quantum leap into the global market. With a target of 10 per cent growth in Gross Domestic Production, India is set to shine brighter in the coming years. At the time of our gaining Independence, Jawaharlal Nehru said, *'Everything else can wait, but not Agriculture'*. Unfortunately this profound truth is yet to be converted into concrete policies and action on an adequate scale. Integrated Farming System approach for sustainability and enhanced productivity is widely accepted as the future road map for Indian agriculture. Modern high Input mono cropping based intensive agriculture has resulted in loss of biodiversity of beneficial fauna and flora, outbreak of pests and diseases, degradation of soil health and decline in productivity, climate change, a serious concern is suspected to be one of the major reasons for the outbreak of new pests and diseases. Over dependence on chemical pesticides has become untenable in view of the health hazards and environmental pollution leading to elimination of several non target beneficial fauna like natural enemies, bees, pollinators, birds, reptiles and small mammals. The high cost and development of resistance in pests make the use of chemical pesticides unsustainable. Therefore, a pest management technology that is economically viable, socially adaptable and environmentally safe ensuring maintenance of resource base should be adapted. There exits in nature, a well-maintained balance between herbivores and their natural enemies (parasitoids, predators, and pathogen) ensuring that pests do not get out of control.

The 'Tomato' (*Lycopersicon esculentum* Mill.) is one of the most important "protective foods" both because of its special nutritive value and

because of its widespread production. It is the world's largest vegetable crop after potato and sweet potato, but it tops the list of canned vegetables. Tomatos are used for soup, salad, pickles, ketchup, puree, sauces and in many other ways. The inhabitants of Central and South America have used tomatoes as food since prehistoric times. It has originated in Peruvian and Mexican regions. It was introduced into Europe by the Spanish explorers in the early sixteenth century. European migrants later on introduced it to the U. S. A. and Canada. The Portuguese perhaps introduced it into India though there is no definite record of when and how it came to India. Tomato is now the most widely grown vegetable crop in India. It is grown throughout the country in farm gardens, small home-gardens, and by market gardeners for fresh consumption as well as for processing purposes. They have an outstanding vitamin contents like ascorbic acid or vitamin C, vitamin A, thiamine or vitamin $B_1$ and riboflavin or vitamin $B_2$.

As per the tomato is important `Protective food` but there are tremendous use of pesticides for the control of the pests on this crop That's resulted into several adverse effects like pest resistant to pesticides, pest resurgence, pesticides residues, food poisonings, health hazards, destruction of biological fauna, ecological imbalance and environmental pollution besides increased cost of production. The ability of some of these pests to develop resistance curbs the effectiveness of many commercial chemicals. Resistance has accelerated in many insect species and it was reported that more than 500 insect and mite species are immune to one or more insecticides at present. Similarly about 150 plant pathogens such as fungus and bacteria are now shielded against fungicides. Experts assessment revealed that around 22 per cent of yield losses in major crops like Rice, Cotton, Groundnut, Sugarcane, Sorghum, Tomato, Chillies, Mango, Grapes, etc., can be attributed to insect pests. Also several important cash crops are now being tested for pesticides residues i.e. phytosanitary certificate, before accepted as import by several countries. All above problems demand new way of thinking of non-toxic, cost effective and indigenous methods of plant protection, which includes cultural, mechanical and biological practices, these are not all together new concepts for farmers

Modern agricultural technologies laid major emphasis on the use of high yielding varieties/hybrids, fertilizers, assured irrigation and plant protection umbrella. However, such intensive farming has also increased the dependence on pesticides, the use of which increased from 14630 tonnes in 1965-66 to 75033 tonnes (technical grade) in 1990-91. The increased and indiscriminate use of pesticides has resulted in resurgence of some non-target pests and resistance in some others to certain insecticides. The IPM approach promoted by the Government of India (GOI), since 1985 is an eco-friendly strategy of pest containment by exploiting the role of natural agents, forces in harmony with other pest management tactics and with the sole aim to effect minimum disturbance to environment. Cultural control, use of natural enemies and plant resistance are basically compatible and supportive tactics in the IPM strategy. The Government of India is also a signatory to the Agenda 21$^{st}$ of United Nations Conference on Environment Development (UNCED) 1992, which has also approved and accepted IPM to reduce the use of pesticides in agriculture.

The Integrated Pest Management (IPM) concept is being promoted through 26 Central Integrated Pest Management Centers (CIPMCs) located in 22 States and one Union Territory (UT). (Chandarkar, 2003). Aiming at human resource development, these centers are imparting trainings to extension functionaries and farmers in IPM skills by conducting Farmers' Field Schools (FFSs) and IPM demonstrations. In addition, these centers are engaged in mass-production and field releases of bio-control agents. Besides, these centers for forewarning and undertaking timely control measures are also doing the monitoring of pests and diseases. During 1994 to 2001, 6,733 Farmer's Field Schools (FFSs) are conducted and training of 28,459 Agriculture Extension Officers and 2,03,032 farmers in IPM skills. About 1100 Master Trainers in IPM have also been trained by conducting 33 Season Long Trainings on cotton, rice, vegetables, pulses, oilseeds etc. The field based trainings to farmers have created an awareness about the IPM concept and empowered them for taking their own decision in adopting the plant protection methods with need based pesticide use considering the increasing degradation of environment and pesticidal residues in farm produce. As a result of implementation of IPM programmes (Chandarkar, 2003), There has

been a significant reduction in the consumption of pesticides from 67,357 tonnes during 1994-95 to 46,196 tonnes (technical grade) during 1999-2000. However, there seems no effective and strong mechanism at place to provide a regular services to the farmers, on day to day basis, in terms of forecasting / forewarning the likely outbreak / infestation of pests and suggesting them to take appropriate preventive and control measures, with adequate back up to supply the biocontrol agents for field use. Strengthening of IPM infrastructure especially for surveillance and forecasting the out break of pests and diseases and production/multiplication of bio-control agents for field use is need to be given adequate attention. Besides, unless the reliable methods of forecasting are developed and bio-control agents are made available on demand farmers would not adopt IPM in true spirit. In this approach, greater emphasis is laid on use of bio-pesticides, pheromones and biological control agents to kept pest population below Economic Threshold Level (ETL) (Anonymous, 2001).

The Government of Maharashtra has introduced integrated pest management programme since 1995 through Training and Visit system in Maharashtra state. Under National Horticulture Mission in Maharashtra 50 per cent or Rs. 1000/ha. for integrated pest management in vegetables as a subsidy upto 4 ha. for one farmer. Also for conducting demonstrating plot on 29.990 ha. was estimated for that Rs.300.00 lakhs amount are estimated by state Agricultural Department in 2005-06 year. (Anonymous,2006a)

## 1.1 What is IPM

IPM is a system that in the context of the associated environment and the population dynamics of the pest species utilizes all suitable techniques and methods in as compatible manner as possible and maintains the pest populations at levels below those causing economic injury. In integrated pest management both crop and pest are seen as part of a dynamic agro-ecosystem.

IPM attempts to capitalize on natural biological factors that limit pest out breaks, only using chemicals as a last resort. The goal is to reduce crop damage to a level where it is economically tolerable, using control measures whose cost both economic and ecological is not excessive. A number of non-chemical cultural practices form the core of IPM. But IPM does not include

chemical pesticide usage. Pesticide usage is one of weapons in the management armory to us that can be exploited sensibly and judiciously.

The Government of Maharashtra introduced IPM programme since 1994-95 but still farmers are not adapting to the large extent. The important IPM practices were as below.

**A, Cultural Practices**

1. Clean up campaign
2. Deep ploughing.
3. Crop rotation.
4. Use of pest tolerant hybrid varietis.
5. Clean cultivation.
6. Inter cultivation
7. Application of recommended fertilizer dose.

**B. Mechanical or Physical Practices**

1. Hand picking of affected plant parts
2. Clipping of terminal shoot.
3. Mulching.
4. Bird Perchers.
5. Light traps.
6. Pheromone traps

**C. Biological Control Practices**

1. Conservation of natural enemies like Chrysoperla, Lady bird Beetle, Wasps, Bugs etc.
2. Augmentation of natural enemies.
3. Use of *Trichogramma pestisomus*.
4. Use of Chrysoperla.
5. Use of HaNPV (Helicoverpa Nucluear polyhydrosis Virus).
6. Use of Bt (*Bacillus thuringiensis*).
7. Use of Biopesticides like NSKE (Neem seed Karnel Extract).

**D. Chemical Practices**

1. ETL (Economic Threshold Level) of pests
2. Seed treatment.
3. Spraying of Insecticide and pesticides.

## 1.2. Need of study

Integrated Pest Management are having good prospects in Haveli tahasil because of maximum area of vegetables under Tomato cultivation. Tomato is mostly used for table purpose but there is maximum use of pesticide for control of diseases and pests. So, as to reduce the hazards effects of chemicals and also it is generally observed that the farmers are not using IPM technology on full scale. So it is necessary to study the extent of IPM technology used in the area, so that the present investigation was undertaken to know their suggestions and accordingly recommendations could be made to improve existing situation.

## 1.3. Objectives

The present study entitled 'Study on Adoption of Integrated Pest Management (IPM) Technology in Tomato *(Lycopersicon esculentum* Mill.) was undertaken to access the knowledge and adoption level of the Tomato Growers with the following specific objectives.

1. To study personal and socio-economic characteristics of the Tomato Growers.
2. To study the knowledge of Integrated Pest Management (IPM) technology of the Tomato Growers.
3. To study the adoption of Integrated Pest Management (IPM) technology of the Tomato Growers.
4. To study relationship between the selected characteristics of the Tomato Growers with their adoption.
5. To study the constraints faced by the Tomato Growers in adoption of IPM technology and the suggestions made by them to overcome the constraints.

## 1.4. Hypothesis

The personal and socio-economic characteristics of tomato growers will be related to their level of adoption of Integrated pest Management (IPM) technology.

## 1.5 Scope of study

The finding of the present study would be help to understand the knowledge and adoption level of various practices of IPM technology by tomato growers for pest management. The finding will provide useful guidelines for planning extension strategies by the extension personnel for creating awareness and preparing the tomato growers to adopt the technology. It will also help to plan for removal of bottlenecks in the way of popularizing the IPM technology among tomato growers. The present study aims at gaining an insight into the selected characteristics of tomato growers from selected villages from Haveli tahasil of Pune district in Maharashtra state.

## 1.6 Limitations of study

The present study is confined to ten villages of Haveli tahsil of Pune district of Maharashtra. The finding emerged out of this study cannot be generalized and applied to other district of Maharashtra, which may have different situation. It would therefore be limited to this areas or similar to it. Moreover, student research worker conducts the present study, hence it will be limited only to the practices of IPM on Tomato. The generalization that would be brought out need to be confirmed by undertaking similar studies in other areas of the state.

## 1.7 Organization of Thesis

The present research study has been presented in five major Chapters. In first chapter, the introduction of the research under study is given. The importance of tomato, what is mean by IPM?, objectives of study, hypothesis, need of study and scope of study.

The second chapter ‘Review of Literature’ is consist of review of relevant literature and findings of past research studies in different locations. The third chapter is concerned with details of ‘Methodology’ used for conducting study. The finding of the study along with Discussion has been presented in the fourth chapter ‘Result and Discussion’.

The last and fifth chapter contains ‘Summary and Conclusions’ of the research work and Implications. Literature cited, Appendices’ and ‘Vita’ has followed at the end.

# 2. Review of Literature

Review of literature is an essential aspect, which helps the researcher to get more acquainted with the subject matter and channelise his efforts towards the desired goals. References related to the similar researches have been presented in following subpart.

2.1 Personal and socio-economic characteristics of tomato growers.

2.2 Relation between personal and socio-economic characteristics of tomato growers with their adoption

## 2.1. Personal and Socio-economic characteristics of tomato growers

### 2.1.1 Independent variables

#### 2.1.1.1 Age

Vasava (1997) revealed that nearly half of the tribal and non tribal tomato growers (50.00 and 43.70 per cent) were in the middle age group followed by 33.30 and 43.30 per cent under old age group. Only 16.70 and 10.00 per cent of tribal and non-tribal tomato growers were in the younger age group respectively.

Pawar (2002) found that 46.00 per cent of the tomato growers belonged to middle age group followed by the old (32.67 per cent) and young (21.33 per cent) age group respectively.

Ghadge (2005) observed that the large proportion of pomegranate growers belonged to middle age group (47.00 per cent) followed by young (22.50 per cent) age group.

Bhosale (2003) observed that the majority of pomegranate growers belonged to middle age group followed by 30.00 per cent and 23.75 per cent from young and old age group respectively.

Borse (2002) revealed that the higher percentage of the cotton growers was in middle age group of 36 to 50 years. This was followed by 33.64 per cent of respondents belongs young age group and 11.82 per cent was in old age group.

Kulkarni (1999) reported that maximum number of ginger growers i. e. 37.33 per cent were from middle age group followed by young age (33.33per cent) and (29.33 per cent) respondent were from old age group.

### 2.1.1.2 Education

Chavai (2005) found that the 40.66 per cent of the cotton growers having secondary education followed by 25.34 per cent have collage education, 32 per cent had primary education and only 4 per cent was illiterate.

Katkar (2000) revealed that most of the drip adapter (40.00 per cent) had secondary education, 20.00 per cent and 12.00 per cent had higher education and primary education respectively, where as only 6.00 per cent were illiterate.

Borse (2002) noted that 37.27 per cent of the cotton growers were educated upto secondary level, 18.18 per cent upto primary school, 13.64 per cent upto graduate and post graduate level, while 10.91 per cent of the hybrid cotton growers have not received any education.

Ghadge (2005) revealed that about (85.00 per cent) of pomegranate growers were literate while only (15.00 per cent) of pomegranate growers were illiterate.

Hinge (1997) observed that considerable number of tomato growers (43.33 per cent) had received primary education and 24.00 per cent had secondary education.

Pawar (2002) found that 20.00 per cent tomato growers were illiterate and primary, secondary and higher secondary education of the respondents were 20.67, 15.33 and 26.00 per cent respectively.

Vasava (1997) found that the maximum number of tribal and non-tribal tomato growers had the secondary level of education.

Veeraiah R. *et al.* (2005) found that 16 per cent of cotton growers were illiterate, 28 per cent were up to primary education and 56 per cent have college education.

### 2.1.1.3 Annual Income

Pawar (2002) observed that majority (68 per cent) of the tomato growers had medium level of annual income, followed by 17.33 per cent and 14.67 per cent who had high and low level of annual income respectively.

Ghadge (2005) revealed that 27.50 per cent of the pomegranate growers had an annual income between Rs.1,50,001 to 2,00,000, while 20.00 had income between Rs. 1,00,000 to1,50,00 and 19.18 per cent of them had annual income above Rs.2,00,000 and duly 11.66 per cent of them had annual income below Rs. 50,000.

Anonymous (2004), AGRESCO report on technological gap in pomegranate cultivation (2002) indicated that about 46.86 per cent of the pomegranate growers had annual income between Rs.10,000 to Rs. 25,000 while one fourth (24.50 per cent) of farmers had annual income Rs. 4,00,000 and above.

Borse (2002) found that more than 50.00 per cent of cotton growers belongs to medium annual income group while 25.45 per cent of them were having high annual income and 23.00 per cent were having low income.

Shinde (1997) observed that three fourth (76.67 per cent) of the groundnut growers had medium level of annual income followed by those having high (15.56 per cent) and low (7.78 per cent) annual gross income.

Chavai (2005) found that the cotton growers (74.67 per cent) had an annual income between Rs.40,000 to 60,000, however 14.66 per cent respondents had annual income between Rs.60,000 to 80,000 and 16 percent had Rs. 80,001 to 1,00,000.

Anonymous (1996a) reported majority (63.00 per cent) of the integrated pest management practicing cotton growers of demonstrating and non-demonstrating group had annual income up to Rs. 50,000.

#### 2.1.1.4 Land Holding

Kharat (1996) observed that 43.33 per cent of pomegranate growers having land 2.01 to 5.00 ha., while remaining 31.61 per cent and 25.16 per cent pomegranate growers up to 2.00 ha. and above 5.01 ha. of land holding respectively.

Phadtare (1999) reported that nearly half (50.80 per cent) of the onion growers had medium size of land holding, 28.40 per cent had small holding and 20.30 per cent had large holding.

Katkar (2000) reported that majority (66.00 per cent) of drip adopter had medium land holding, while 28.00 per cent had big size of land holding, only 6.00 per cent of respondent had small land holding.

Bodake (2003) observed that 46.00 per cent of respondent had medium land holding and 32.66 per cent respondent had low land holding, while 21.34 per cent respondent had high land holding.

Pawar (2002) found that 53.33 per cent of tomato growers had small size of land holding, followed by 30.76 per cent and 16.00 per cent having medium and large sized farm respectively.

Kashyap (2000) observed that vegetable growers had small size of land holding.

#### 2.1.1.5 Social Participation

Anonymous (1996b) reported that 78.00 per cent of IPM practicing cotton growers of demonstrating and non demonstrating were member of credit co-operative society, followed by co-operative sugar factory (74.00 per cent), co-operative spinning unit (61.00 per cent), dairy co-operative (18.00 per cent) and other organizations (6.00 per cent).

Vasava (1997) reported that majority of tribal areas mango and tomato growers had participated in two organizations, while in case of non tribal were member of more than two organization.

Chikhale *et al.* (1996) pointed out that (42.00 per cent) of orange growers had medium social participation followed by (38.50 per cent) of the responent had low social participation, while (19.50 per cent) of the respondents were form high social participation category.

Borse (2002) found that half of the hybrid cotton growers had medium level of social participation, 30.00 per cent of them had low level of social participation, while 20.00 per cent of them had high level of social participation.

Patil (1995) reported that more than half (56.34 per cent) of the respondent had medium level of social participation.

#### 2.1.1.6 Sources of Information

Thakur *et al.* (1991) found that information source of mango growers were radio (43.23 per cent), television (30.60 per cent), it was followed by

newspaper (22.52 per cent), farmers in village (21.62 per cent) and progressive farmers (9.82 per cent).

Ghadge (2005) observed that 49.17 per cent of the pomegranate growers had used medium sources of information, while 30.83 and 20.00 per cent of them had low and high sources of information respectively.

Subharaidu (1993) reported while studying the adoption of cotton technology that, contact with regional agricultural research station emerged as an important source of information for the cotton grower seeking information about integrated management practices, followed by village extension worker, Agricultural Officer, University scientists and progressive farmers.

Pawar (2002) found that 46.67 and 35.33 per cent of the tomato growers had used medium and high sources of information, while 18.00 per cent of tomato growers had used low sources of information.

Nadre (2000) revealed that farmers used one or more than one source, Gramsevak (80.70 per cent), radio (76.9 per cent) and television (71.6 per cent) were the major sources of information. Among the informal sources, friends were ranks first (38.4 per cent) followed by relatives (34.6 per cent) and neighbors (32.7 per cent).

Deokate (1998) found that about one third (31.81 per cent) of the jasmine growers had used high level of source of information, while 44.45 per cent growers used medium sources of information and near about one fourth (23.65 per cent) jasmine growers used low sources of information regularly.

Padalkar (1996) revealed that most of the turmeric growers (76.67 per cent) were using sources of information occasionally, while 17.00 per cent of them were using all information sources rarely and only 6.00 per cent were using source of information regularly.

Maria Mauceri (2004) found that out of 109 farmers, 30 (27.00 per cent) acquired IPM information through participation in FFS, 29 (27.00 per cent) farmers heard about IPM from other farmers, 17 (16.00 per cent) farmers attended field days and 14 (13.00 per cent) received pamphlets on IPM. Only 18 (17.00 per cent) farmers indicated that they had not received information on IPM.

### 2.1.1.7 Knowledge

Aghav (1997) revealed that 48.61 per cent of the vegetable growers had medium level of knowledge followed by 27.97 per cent possessing high level of knowledge and 23.31 per cent belonged to low level of knowledge.

Sriram (1997) found that out of 19 eco-friendly agricultural practices viz. summer ploughing, variety selection, season, trap cropping, crop rotation, alternate furrow irrigation, mechanical control of pest etc were well known to farmers (70.80 per cent).

Chapke (2000) found that more than (60.00 per cent) of the respondent had full knowledge about practices viz. spraying, adding teaspoon detergent (100gm) per 250 ml of HaNPV, second spray at 15-20 days.

Ghadge (2005) found that majority of the pomegranate growers had complete knowledge about cultural practices and also regarding mechanical control, Three fourth (75.83 per cent) had complete knowledge about collection and burning of affected fruits, leaves, branches and dead wood for control of oily spot in pomegranate.

Chavai (2005) found that majority (56.00 per cent) of the respondents were in the medium knowledge level group, while 31.24 and 12.66 per cent of them were having high and low knowledge level respectively about IPM in cotton.

Vasava (1997) revealed that 80.00 per cent of the tribal and non tribal tomato growers both possessed medium level knowledge, followed by high level in tribal tomato growers, only 6.70 per cent of the both group possessed low level and high level of knowledge respectively.

Kashyap (2000) found that the vegetable growers had some extent of knowledge about plant protection measures in vegetable cultivation.

Patel (2001) revealed that the majority (75.00 per cent) of brinjal growers had medium level of knowledge, while 21.00 per cent of the brinjal growers had low level of knowledge and only 4.00 per cent respondent had high level of knowledge regarding plant protection measures in brinjal crop.

Kalaskar *et al.* (2001) found only 16.47 per cent of respondent had high and 15.76 per cent of them had low level of knowledge about different

IPM practices while majority of them (67.27 per cent) were moderately aware about different IPM practices.

Katole *et al.* (1996) reported that majority of respondent had knowledge about cultural, mechanical, chemical and physical control measures, whereas 40.67 per cent of them were aware about spraying of neem seed extract, however meager percentage of them were aware about biological control measures and use of pheromone traps.

Bhairamkar *et al.* (1998) observed that more than half (53.33 per cent) of beneficiaries had high knowledge, while 26.67 per cent of them had no knowledge about IPM practices.

Bhople *et al.* (2001) found that majority of respondents (73.33 per cent) belonged to low category while 22.00 per cent of them had medium and only a meager per cent of them (4.68 per cent) had adequate knowledge about bio-control practices recommended for pest management in cotton.

Veeraiah. R *et al.* (2005) reported that overall knowledge level of the cotton farmers under IPM technology, 70 per cent respondents were medium while 10 and 20 per cent having low and high knowledge level respectively.

### 2.1.2 Dependent variable

#### 2.1.2.1. Adoption

According to Rogers (1983) adoption is a decision to make full use of innovation as the best course of action available. Thus, adoption is the process of adopting an existing idea.

Adoption as viewed by the rural sociologists, is not a snap decision but a process. Important nature of adoption process is that it occurs in different stages.

Rogers and Shoemaker (1971) formulated five stages in their conceptualization of adoption process. These were knowledge, persuasion, decision, implementation and confirmation.

### Adoption of IPM technology

Chapke (2000) concluded that 85.40 per cent respondents had overall moderate adoption level about bio-control measures. A negligible percentage of the respondents (5.60 per cent and 8.04 per cent) had low and

high adoption level respectively about bio-control measures for controlling bollworms on cotton.

Iqbal *et al.* (1995) reported that more than half of the respondents were having medium level of adoption of recommended IPM practices.

Shinde *et al.* (1997) reported that majority of cotton growers did not adopt the mechanical and biological practices of IPM programme.

Basavaprabhu (1997) reported that majority of the farmers were medium in adoption of IPM practices on vegetable crops.

Backwad (1997) reported that biological method of IPM was adopted by the farmers on large scale resulting in reduction of pesticide use.

Kalaskar *et al.* (2001) revealed that overwhelming majority of the respondents (85.45 percent) adopted the cultural practices like grazing by sheep and goat in cotton field after last picking to check the further hibernation of insects. Deep ploughing (100 per cent) for exposing soil hibernating stages of pests, crop rotation (95.15 per cent) for interrupting breeding and multiplication of pests and using pest resistant tolerant variety (92.73 per cent) as per recommendation. As regards to the mechanical practices like hand picking and destruction of larvae, clipping affected terminal shoot removal and destruction of rossette shaped flowers, infected bolls, leaves and use of yellow sticky pans were not adopted by the majority. In case of adoption of biological methods like installing perches for birds, releasing parasites (Trichoderma) and predator (Chrysoperla), spraying *Bacillus thuringiensis***,** it was observed that no respondent found to adopt these practices, HaNPV was adopted by 24.84 per cent and spraying of Neem seed extract (NSE) was followed by 60 per cent of the respondent as per recommendations. While few respondents used the sex pheromone traps either completely or partially. Regarding chemical control, prophylactic spraying of dimethoate was followed by overwhelming majority as per recommendation, where as over two third of them adopted the practices of restricting the two sprays of pyrethroid's depending upon the optimum level of economic injury.

Nadre (2000) revealed that in respect of introduction of IPM, the low cost technologies like crop trap, pheromone trap, light trap, HaNPV, *Trichogramma chilonis* and Crysopa eggs etc. were not adopted by farmers.

Bhople (2001) revealed that 49.39 per cent of the respondents used neem seed extract. The use of HaNPV was about 25.00 per cent. Adoption of BT and Crysopa was very meager. None of the farmers had used *Bacillus substilis.* The overall use of bio-control practices for pest management in cotton by the farmers was found to be only 17.75 per cent. It was further revealed that majority of the respondents (81.33 per cent) had low level of adoption of bio-control practices for pest management in cotton.

Patel (2001) found that majority (78.0 per cent) of the tomato growers possessed medium level of adoption, followed by low level (18.00 percent) of adoption of plant protection measures in tomato.

Chavai (2005) found that majority (76.67per cent) of the cotton growers were in the medium adoption category and 20.00 per cent of them were in high category, however very negligible of them (9.33 per cent) were in low adoption of IPM practices.

Kubade *et al.* (1996) revealed that (85.40 per cent) respondent had overall moderate adoption level about biocontrol measures and negligiable percentage of respondents had low and high adoption level about biocontrol measures.

Rangari *et al.* (2000) observed that majority (72.50 per cent) of the respondent used recommended varieties, seed treatment, fertilizer, plant protection measures.

Ghadge (2005) revealed that majority (79.17per cent) of the pomegranate growers had medium level of adoption of recommended control measures, few (15.00 per cent) and very low (5.83per cent) of them had low and high adoption level of oily spot disease in pomegranate, respectively.

Pawar (2002) revealed that high percentage of tomato grower (67.37 per cent) had medium level of adoption of post harvest technology and market information, nearly one fifth had low (16.67 per cent) and high (20.00 per cent) level of adoption.

Robertson *et al.* (2005) observed that the majority of cotton growers fell into the medium or high IPM rankings. However, only 7 per cent of respondents attained a high IPM ranking in the Cultural Pest Management section, the major difference was that the majority of growers (87 per cent) fell into the medium ranking, indicating they often used cultural IPM practices,

while only 7 per cent indicated that they always used recommended cultural practices. From the pesticide application section indicated that 46.5 per cent and 52 per cent of growers fell within the medium and high IPM categories respectively.

Maria Mauceri (2004) observed that 20 per cent of farmers did not use any IPM (Category I). 42.2 per cent used more than half of the recommended IPM technologies (Categories IV and V). Comparing between IPM use farmer groups, note that 40 per cent of farmers who were randomly selected did not use any IPM. 60 per cent of the farmers who used more than 50 per cent of IPM practices.

Bonabana-Wabbi, Jackline (2002) analyzed that adoption of eight IPM technologies on cowpea, sorghum and groundnuts. Low levels of adoption (less than 25 per cent) were found with five of these technologies while three technologies had high adoption levels (more than 75 per cent).

## 2.2. Relation between personal, socio-economic characteristics of tomato growers with their adoption

### 2.2.1 Age and adoption

Hinge (1997) observed that relationship between the age of the tomato growers and the level of adoption of tomato cultivation practices was non-significant.

Deshmukh (1996) stated that age of custard apple growers was negatively and significantly related with adoption.

Pawar (2002) found that there was a statistically significant association between age of the tomato growers and their level of adoption, the middle age group of tomato growers had higher level of adoption followed by oldder age group as compared to the younger tomato growers and vice-versa.

Dhule (2000) reported that age of farmer was not related with awareness and adoption of plant protection measures.

Sutar (1997) noticed that age of custard papaya growers was negatively and significantly related with their adoption level.

Bodake (2003) reported that there is non-significant relationship between age of farmers and their adoption of bio-fertilizers.

Kalaskar (1999) reported that age did not have any significant correlation with adoption of the cotton growers about IPM.

Borse (2002) found that relationship between the age and adoption of IPM technology in cotton was found to be non-significant.

### 2.2.2 Education and adoption

Chavai (2005) observed that relationship between education and adoption level of respondents was found to be positively significant. The more education might have resulted in increased knowledge level which might have contributed for more adoption of IPM technology in cotton.

Ahire (1997) noticed that there was a positive and significant relationship between education level of grape growers and adoption behavior.

Borse (2002) noticed that relationship between education and adoption of IPM technology by hybrid cotton growers was found to be positive and highly significant.

Pawar (2002) observed that there was significant association between education level of the tomato growers and their adoption level.

Ghadge (2005) found that the relationship between the education and adoption level of pomegranate growers was highly significant.

### 2.2.3. Annual income and adoption

Hinge (1997) stated that annual gross income of tomato growers exhibited positive and highly significant relationship with their adoption level.

Kalaskar *et al.* (1999) observed that the annual income was highly significantly correlated with the adoption of IPM practices.

Chavai (2005) found that the annual income of respondents exhibited positive and significant relationship with their adoption level of IPM technology in cotton.

Ghadge (2005) observed that the relationship between annual gross income and adoption of pomegranate growers was positive and highly significant.

**4) Land holding and adoption**

Chavai (2005) found that relation between land holding and adoption level of various practices of IPM Technology of cotton was found to be positive and significant.

Farnandez *et al.* (1994) reported that land holding had significant relationship with the adoption of IPM practices by vegetables growers.

Hinge (1997) found that the relationship between farm size and adoption level of various cultivation practices of tomato was highly significant.

Bhujbal (1995) concluded that the size of land holding of fig growers was significantly associated with their level of adoption.

Pawar (2002) found significant association between size of land holding of the tomato growers those who had larger size of land holding had higher level of adoption and vice-versa.

Kalaskar *et al.* (2001) found that land holding was highly significant with adoption possessed by the respondent about integrated pest management.

Liu Yonggong and Xue Shu (2004) concluded that there was no link between farm size for vegetable production and the level of adoption of different IPM techniques

## 2.2.5. Social participation and adoption

Deshmukh (1996) found that social participation of custard apple growers was positive and significantly related with the level of adoption.

Kharat (1996) found that there was significant correlation between social participation of pomegranate growers and their level of adoption of improved practices of pomegranate cultivation.

Venkatesh and Siddramaiah (2000) found that there was a positive and significant association between social participation and adoption of plant protection measures of paddy and groundnut growers.

Pitrubhakta (2000) found that their existed association between social participation and adoption of improved practices of rainfed cotton growers.

Borse (2002) noticed that there was positive and significant relationship between social participation and adoption of IPM technology.

### 2.2.6. Sources of information and adoption

Dhule (1999) reported that source of information was significantly related with adoption of biocontrol practices for pest management by cotton growers.

Kalaskar *et al.* (1999) observed that source of information was significantly correlated with adoption of IPM practices of the respondents.

Pawar (2002) noticed that there was significant association between use of number of source of information by tomato growers and their level of adoption.

Shivasharanappa and Nagaraja (1997) showed that source of information was significantly associated with adoption of vegetable cultivation practices.

### 2.2.7. Knowledge and adoption

Kalaskar *et al.* (1999) found that knowledge about IPM technology was significantly correlated with the adoption of IPM practices of cotton growers.

Bhujbal (1995) observed that there was significant association between knowledge level of fig growers and adoption of improved practices of fig cultivation.

Vasava (1997) observed that there was highly significant relationship between knowledge and adoption level of both groups of mango and tomato growers.

Bhagwan Singh (2004) reported that knowledge of the respondent was positive and significantly related with overall adoption of seasamum production technology.

Shinde (1997) found negative and significant relationship between knowledge level and adoption of improved cultivation practices by groundnut growers.

# 3. Research Methodology

In order to have the research on sound footing the researcher has to take support of various methods, techniques and tools. He has to accurately define the measure the concepts. For this the researcher needs to know the procedure so that he can go through it and putforth the efforts in that direction with the same intention. This chapter deals with the research methods, procedure, techniques used in the present investigation, which has been discussed with relevant details under following captions.

3.1 Locale of study
3.2 Methods of sampling and size of sampling.
3.3 Preparation of interview schedule and pretesting.
3.4 Methods of data collection.
3.5 Measurement scoring and categorization of variables.
3.6 Data processing and statistical methods used.
3.7 Operational terms used.

## 3.1. Locale of study

The present investigation was conducted in purposefully selected Haveli tahsil of Pune district of Maharashtra state because it is a predominant tomato growing area around Pune City. The two Municipal Corporations namely Pune Municipal Corporation (PMC) and Pimpri-Chinchwad Municipal Corporation (PCMC) are in Haveli tahsil. Maximum area comes under urbanization and industrialization. Haveli tahsil is surrounded by Bhor, Velha, Purandhar, Daund, Shirur, Khed, Mulsi and Maval tahsils of Pune District.

### 3.1.1 Area and land utilization pattern

The total geographical area of Haveli Tahsil is 130142 ha. The land utilization pattern of Haveli Tahsil is given as below.

**Land utilization pattern of HAVELI tahsil**

| Sl. No. | Classification | Area (Ha.) |
|---|---|---|
| 1 | Geographical Area | 130142 |
| 2 | Barren and uncultivable land | 37103 |
| 3 | Other fallow | 9115 |
| 4 | Land put to non-Agril. use | 3062 |
| 5 | Grazing land | 1808 |
| 6 | Permanent fallow | 13845 |
| 7 | Rivers and Drains | 1409 |
| 8 | Area under forest | 7864 |
| 9 | Total cultivable area | 93039 |
| 10 | Total cultivable fallow land | 17865 |
| 11 | Net sown area | 75174 |
| 12 | Area sown more than once | 12156 |
| 13 | Gross cropped area | 87331 |

Source: Anonymous (2006b)

### 3.1.2. Cropping pattern

The major crops of the Haveli tahsil are vegetables. Although the major crops are Paddy, Bajara, Groundnut, Kharif Jowar, rabi Jowar, Wheat and Sugarcane. The total area under Kharif crops is 20,300 Ha. area And 26,400 Ha. area under Rabi crops and only 300 Ha. area under the Summer Crops. The cropping pattern is as below

**Cropping pattern of HAVELI tahsil**

| Sl. No. | Crops | Area (Ha.) |
|---|---|---|
| 1. | Kharrif Rice | 2600 |
| 2. | Bajara | 11700 |
| 3. | Tur | 600 |
| 4. | Mung | 500 |
| 5. | Kharif Groundnut | 2700 |
| 6. | Sugarcane | 7400 |
| 7. | Rabi Jowar | 18500 |
| 8. | Wheat | 3600 |
| 9. | Gram | 2200 |
| 10. | Summer Groundnut | 200 |

Source: Anonymous (2006b)

## 3.2. Methods of sampling and size of sampling.

### 3.2.1. Selection of tahsil

The Haveli tahsil is selected purposefully because area under tomato crop in Haveli tahsil was 530 ha. production 265.00 MT and productivity is 500.00 Q/ha. in year 2004-05 as against Pune district area was 7467 ha., production 254115 MT and productivity was 340.32 qt/ha. (Anonymous, 2006b)

### 3.2.2. Selection of villages

The list of villages in Haveli tahsil is collected from the Taluka Agriculture Officer and ten villages were selected which having maximum area under the tomato cultivation. The list of selected villages is given in Appendix - I

### 3.2.3. Selection of respondents

From each villages list of tomato growers was prepared by key information method discussing with extension personnel and serially first 130 farmers were selected as a respondents for the study.

## 3.3. Preparation of interview schedule and pre-testing

A structured interview schedule, consisting relevant questions related with the objectives of the study, was prepared. Every precaution was taken to keep the language local and simple so as to get desired responses from the respondents. The interview schedule was developed in *Marathi* (local language) for better understanding of the tomato growers. The questions about the knowledge and adoption of practices of IPM technology were also included. The interview schedule is given in Appendix – II.

### 3.3.1. Pre-testing of interview schedule

The interview schedule so developed was pre-tested for its accuracy, simplicity and practicability with a group of fifteen farmers. Considering the experience of pre-testing, related questions were put together to have consistency in response. The language of a few questions were modified for easy in understanding and eliciting accurate response. Sufficient number of copies of interview schedule were then prepared and used for collection of data.

## 3.4. Methods of collection of data

The data were collected personally from the sample respondents by adapting personal interview method with the help of interview schedule developed for this purpose. The respondents were contacted at their home or farm as per their convenience. The rapport was established by explaining them the object of study.

## 3.5 Measurement, scoring techniques and categorization of variables

For the present study, two sets of variables were selected. These are as below.

**3.5.1. Independent variables**

1. Age
2. Education
3. Land holding
4. Annual income
5. Social participation
6. Sources of information
7. Knowledge

**3.5.2. Dependent variables**

1 Adoption

**3.5.3. Constraints and Suggestions.**

### 3.5.1. Independent variables

The set of independent variables for the present study, their operational definitions, procedure for scoring and categorization have been presented in this subpart

#### 3.5.1.1. Age

The chronological age of the respondents is in years, measured in terms of completed years at the time of data collection, and considered as individual score. The categorization was done as young, middle and old.

| Sr. No. | Age Group | Age Range (years) |
|---|---|---|
| 1 | Young | Up to 35 |
| 2 | Middle | 36 to 50 |
| 3 | Old | 51 and Above |

### 3.5.1.2. Education

Education was operationally defined as the standard in formal school passed by the respondents. According to the educational standard the respondents were classified into four categories

| Sr. No. | Education | Standard |
|---|---|---|
| 1 | Illiterate | Having no formal education |
| 2 | Primary education | Up to VII Class |
| 3 | Secondary education | VIII to XII Class |
| 4 | College education | Graduate and above |

### 3.5.1.3. Size of land holding

The total land area possessed by the respondents in hectares was considered as the land holding. Following categories were formed on the basis of the existing norms of land holding in Maharashtra state.

| Sr. No. | Land holding | Land in ha. |
|---|---|---|
| 1 | Marginal | Up to 1.00 |
| 2 | Small | 1.01 to 2.00 |
| 3 | Semi-medium | 2.01 to 4.00 |
| 4 | Medium | 4.01and 10.00 |
| 5 | Large | 10.01 and above |

### 3.5.1.4. Annual income:

The total annual income derived from all sources was considered as annual income of respondents. The respondents were divided into five categories for the purpose of analysis based on level of income in rupees of respondents.

| Sr. No. | Income category | Income in Rupees |
|---|---|---|
| 1 | Low | Up to 50,000 |
| 2 | Semi- medium | 50,001 to 1,00,000 |
| 3 | Medium | 1,00,001 to 1,50,000 |
| 4 | Semi-High | 1,50,001 to 2,00,000 |
| 5 | High | 2,00,001 and above |

### 3.5.1.5. Social participation

Social participation refers to the association of an individual with various organizations. Score was calculated on the basis of the respondents' participation in various organizations either as a member or office bearer. One score was given to the membership in each of the institutions/organization and score two was assigned to those who were office bearer in each of the institutions/organization. The total score of the respondent was worked out and they were grouped into three categories on the basis of Mean $\pm$ S.D. The categories were as below.

| Sr. No. | Social participation | Score |
|---|---|---|
| 1 | Low | Up to 1.44 |
| 2 | Medium | 1.45 to 4.79 |
| 3 | High | 4.80 and Above |

### 3.5.1.6. Sources of information

The source of information refers to the use of different sources of information/communication channels used for gaining the knowledge about the IPM technology by the tomato growers. Studying the level of source of farm information used by the respondent and accordingly total score of source of farm information was computed and they were grouped into three categories on the basis of Mean $\pm$ S.D. These categories were as below.

| Sr. No. | Source of information | Score |
|---|---|---|
| 1 | Low | Up to 8 |
| 2 | Medium | 9 to 23 |
| 3 | High | 24 and above |

### 3.5.1.7. Knowledge about IPM technology

English and English (1958) defined knowledge as a body of information possessed by an individual.

Rogers (1983) has classified knowledge into three types, that is ‘awareness knowledge’, ‘how to knowledge’ and ‘principle knowledge’. In the present study, knowledge refers to awareness knowledge.

In the context of the present study, knowledge was operationally defined as the technical know how possessed by the individual tomato growers about various practices of IPM technology for pest management in tomato crop.

A schedule was specially developed and used to measure the knowledge quantitatively. For ascertaining the knowledge a list of 69 practices under four major heads was prepared through the consultation with Entomologists from Department of Entomology, College of Agriculture, Pune, Advisory Committee Members and the relevant literature. The number of practices identified and considered for assessing the knowledge level under four major heads are shown below.

| Sr. No. | Major Head | No. of practices |
|---|---|---|
| 1 | Cultural practices | 23 |
| 2 | Mechanical practices | 12 |
| 3 | Biological practices | 15 |
| 4 | Chemical practices | 19 |
| | Total | 69 |

The respondents were requested to answer each question. The answer to each question may be ‘Yes’ or ‘No’ The responses to each question given by the respondents were categorized into two categories and assigned the scores of 1 and 0 for ‘Yes’ and ‘No’ answer respectively. The scores on all the items of knowledge test of each respondent were summed up and this sum total indicated the knowledge score for that individual respondent. The obtained knowledge score could range from 0 to 69.

On the basis of knowledge score obtained, respondents were categorized into three categories by the method of mean $\pm$ S.D. Three categories were made as below

| Sr. No. | Knowledge | Score |
|---|---|---|
| 1 | Low | Up to 34 |
| 2 | Medium | 35 to 60 |
| 3 | High | 61 and above |

### 3.5.2 Dependent variables

#### 3.5.2.1. Adoption

Rogers (1983) defined adoption as a decision to make full use of an innovation as the best course of action available.

In the present study it is operationally defined as the actual use of recommended IPM technology for the pest management of tomato by the respondent farmers.

For ascertaining the level of adoption of respondents a list of 67 recommended practices was prepared, through the consultation with Entomologists from Department of Entomology, College of Agriculture, Pune, Advisory Committee Members and the relevant literature. The question on each practice was then framed. The questions were asked with regard to actual use of these practices to the Tomato growers.

| Sr. No. | Major Head | No. of practices |
|---|---|---|
| 1 | Cultural practices | 23 |
| 2 | Mechanical practices | 12 |
| 3 | Biological practices | 13 |
| 4 | Chemical practices | 19 |
| | Total | 67 |

For measuring the adoption level of the respondent, three continuum was used and the numerical values were assigned to the responses received from the respondents. The numerical score ‘2’ was assigned for ‘complete adoption’, ‘1’ for ‘partial adoption’ and a numerical score of ‘0’ was assigned for ‘non adoption’ of each practice of IPM technology. The total score for each respondent farmer was computed.

For measurement of the adoption level of the respondent the ‘Adoption Index’ was calculated using the following formula

$$\text{Adoption Index} = \frac{\text{Sum of adoption score obtained}}{\text{Maximum obtainable adoption score}} \times 100$$

On the basis of adoption index obtained the respondents were categorized into following three categories by the method of mean ± S.D of 'Adoption Index'

| Sr. No. | Adoption Index | Score |
|---|---|---|
| 1 | Low | Up to 35 |
| 2 | Medium | 36 to 72 |
| 3 | High | 73 and above |

### 3.5.3. Constraints and suggestions

#### 3.5.3.1 Constraints

The Oxford dictionary meaning of the word constraint is confinement, restriction of liberty or compulsion of circumstances or compulsion put upon the behavior. Constraints are the factors that limit the adoption process and hence these cannot be overlooked.

In the present study constraints have been operationally defined as the problems or difficulties faced by the tomato growers in adoption of IPM technology for the pest management in tomato.

The frequency and percentage of each constraint was worked out to measure the constraints encountered by the respondents.

#### 3.5.3.2. Suggestions

Suggestions were also obtained by asking questions to overcome the constraints faced by them in adoption of IPM technology for the pest management in tomato. The frequency and percentages were worked out.

### 3.6. Data processing and statistical methods used

The collected data were carefully examined for completeness and correctness before tabulation. Both qualitative and quantitative classes were framed. In case of some variables, the classes were formed arbitrarily while in case of some variables accepted standard classification was adopted and remaining variables were classified by using mean and standard deviation.

The data were then tabulated and the frequency and percentage of the respondents In each category were worked out. Following statistical tools were used in the present study for analysis of data.

### 3.6.1 Frequency and Percentage

Frequency and Percentage is used in descriptive analysis for making simple comparison

### 3.6.2. Arithmetic mean (X)

Mean was calculated by using following formula

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i = \frac{1}{n}(x_1 + \cdots + x_n).$$

Where, X - Arithmetic mean

n – Number of observations

Xi – Value of observations

### 3.6.3 Standard Deviation (S.D.)

Standard Deviation (S.D.) was calculated by using following formula

$$\text{S.D.} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2}\ .$$

Where, X - Arithmetic mean

x – Score of each Respondent

n – Number of Respondents

S.D.- Standard Deviation

### 3.6.4 Coefficient of correlation (rxy)

To find out the relationship between the selected independent and dependent variables ‘Karl Pearson’s Coefficient of Correlation (r)’ was worked out by using the following formula.

$$r = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sqrt{\left(\sum x^2 - \frac{(\sum x)^2}{n}\right)\left(\sum y^2 - \frac{(\sum y)^2}{n}\right)}}$$

Where r = Co-efficient of Correlation

x = Independent variable

y = Dependent variable

n = Number of respondents

## 3.7. Operational definitions

### A) Independent variables

**1. Age**

It is operationally defined as chronological age of respondent at the time of interview

**2. Education**

Number of years of formal education successfully completed by the respondent.

**3. Land holding**

It is the area of land in hectares possessed by an individual for cultivation.

**4. Annual income**

It refers to the income in Rs. of all the family members received from all sources in a year.

**5. Social participation**

It is degree of participation of the individuals in any formal and informal organization or institution.

**6. Sources of information**

It is defined as degree to which an individual farmer exposed to mass media like newspaper, radio, Television. Agricultural magazines and other sources.

**7. Knowledge**

The knowledge of the respondent regarding Integarted Pest Management technology in tomato at the time of interview.

### B) Dependent variables

**1. Adoption**

Adoption as mental process through which an individual passes from 1$^{st}$ hearing about an innovation to final adoption of IPM technology in tomato.

# 4. Results and Discussion

The information pertaining to this study was collected from the respondents by means of Interview with the help of structured schedules. The data were classified, tabulated and analyzed in light of the objectives of the study. The findings derived after analyzing the information have been presented under the following main heads and discussed in succeeding pages.

4.1 Personal and socio-economic characteristics of tomato growers

4.2 Knowledge of IPM technology of tomato growers

4.3 Adoption of IPM technology of tomato growers

4.4 Relationship between selected independent variables and adoption level of IPM technology.

4.5 Constraints faced by tomato growers in adoption of IPM technology and their suggestions.

## 4.1 Personal and Scio-economic characteristics of tomato growers.

The data regarding personal, and socio-economic characteristics of the respondents viz, age, education, annual income, landholding, social participation and source of information of various categories depicted in Table.1.

### 4.1.1. Age

The data about the chronological age of the Tomato grower was collected, compiled and presented in the Table.1.

**Fig. 1. Distribution of tomato growers according to their age**

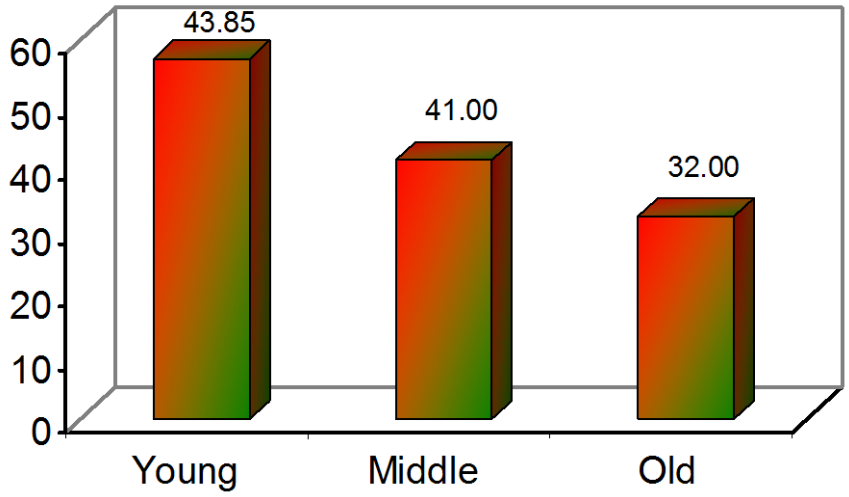


**Table. 1. Distribution of tomato growers according to their Personal and Socio-economic Characteristics**

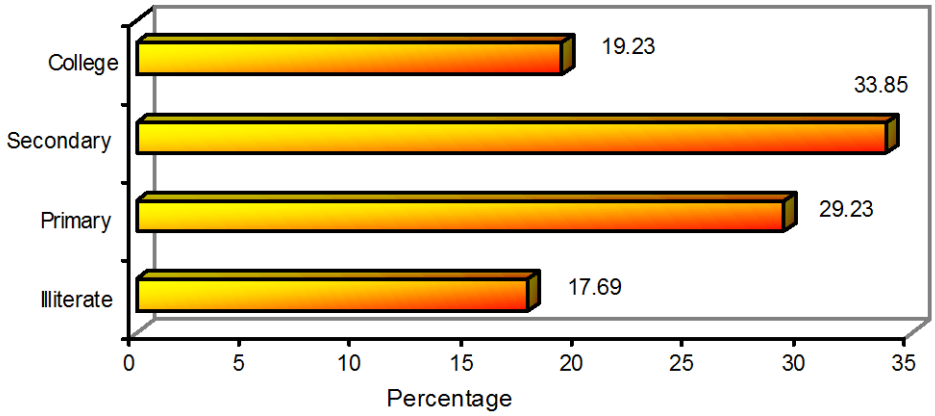
| Sl.No. | Characteristic(s) | Respondents (n=130) | |
|---|---|---|---|
| | | Number | Percentage |
| **Personal characteristic(s)** | | | |
| **I .** | **Age** | | |
| 1 | Young | 57 | 43.85 |
| 2 | Middle | 41 | 31.54 |
| 3 | Old | 32 | 24.61 |
| **Total** | | **130** | **100.00** |
| **Average Age (Years)** | | | **41** |
| **Socio-economic characteristics** | | | |
| **I -** | **Education** | | |
| 1 | Illiterate | 23 | 17.69 |
| 2 | Primary | 38 | 29.23 |
| 3 | Secondary | 44 | 33.85 |
| 4 | College | 25 | 19.23 |
| **Total** | | **130** | **100.00** |
| **Average Education (Std)** | | | **8** |
| **II -** | **Land holding** | | |
| 1 | Marginal | 51 | 39.23 |
| 2 | Small | 41 | 31.54 |
| 3 | Semi-medium | 30 | 23.08 |
| 4 | Medium | 8 | 6.15 |
| 5 | Large | 0 | 0.00 |
| **Total** | | **130** | **100.00** |
| **Average Land Holding (Ha.)** | | | **1.61** |
| **III.** | **Annual income** | | |
| 1 | Up to Rs.50,000 | 14 | 10.77 |
| 2 | Rs.50,001 to 1,00,000 | 30 | 23.08 |
| 3 | Rs.1,00,001 to 1,50,000 | 37 | 28.46 |
| 4 | Rs.1,50,001 to 2,00,000 | 15 | 11.54 |
| 5 | Rs.2,00,001and above | 34 | 26.15 |
| **Total** | | **130** | **100.00** |
| **Average Annual income (Rs.)** | | | **1,64,000** |
| **IV.** | **Social participation** | | |
| 1 | Low | 39 | 30.00 |
| 2 | Medium | 62 | 47.69 |
| 3 | High | 29 | 22.31 |
| **Total** | | **130** | **100.00** |
| **Average Social participation (score)** | | | **3.48** |
| **IV.** | **Sources of information** | | |
| 1 | Low | 25 | 19.23 |
| 2 | Medium | 85 | 65.38 |
| 3 | High | 20 | 15.38 |
| **Total** | | **130** | **100.00** |
| **Average Source of information (score)** | | | **16.17** |

It is observed from Table 1 that 43.85 per cent of tomato growers were belongs to ‘young’ age group followed by ‘middle’ (31.54 per cent) and ‘old’ (24.62 per cent) age group, respectively. Thus, it can be inferred that large proportion of tomato growers’ belonged to ‘young’ age group. It was noted that the average age of tomato grower was 41 years.

### 4.1.2 Education

Better formal education assists the farmer in improving his ability to know science and technology and utilize this modern technology for his betterment. Education also influences knowledge level and extent of adoption. Keeping this point in view, the respondent were grouped into four categories viz. illiterate, primary education, secondary education and college education as in Table 1.

**Fig. 2. Distribution of tomato growers according to their education**




The Table revealed that, 82.31 per cent of the respondents had received education. The proportion of respondents who received ‘secondary education’ was largest (33.85 per cent) while 29.23 per cent of the respondents received ‘primary education’. The 19.23 per cent of the respondent are received the ‘college education’ and about 17.69 per cent are the’ illiterate’.

The average education of the respondent was 8$^{th}$ standard, since the level of the respondent was quite high, so use of literature like leaflets, folders and farm magazines might be beneficial for these respondents. For the illiterate or those who received some formal education the teaching methods namely demonstrations, films, posters, models and specimens may be used. This understanding of educational level of the respondents is useful for the

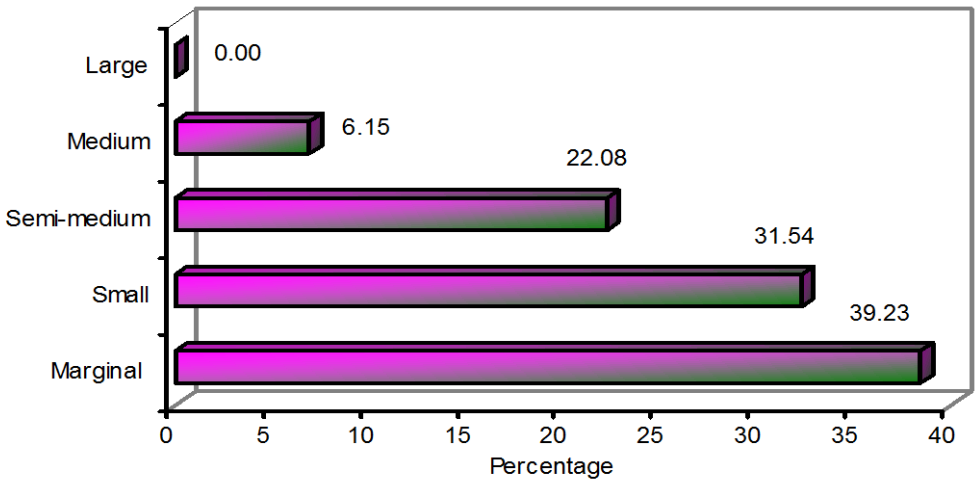
extension workers in selection of appropriate teaching tools and aids for conducting training program about IPM technology.

The result of present study was similar to the trends obtained by Anonymous (1996b), Pitrubhakta (2001), Borse (2003), Chavai (2005), Ghadge (2005), Veeraiah R. (2005) and Pawar (2002).

### 4.1.3 Land holding

The amount of land possessed by a farmer is an important economic parameter to assess his economic standard in the society. Also, land holding is an important factor in relation to the knowledge level and adoption of innovative technology. In the present study, respondents were grouped into five categories Viz. marginal, small, semi-medium, medium and large farmer as shown in Table 1.

**Fig.3. Distribution of Tomato Growers according to their Land Holding**




It is observed from Table 1. that, 39.23 per cent of the respondents were ‘Marginal farmers’ who possessed land up to 1.00 hectares. However, 31.54 per cent, 23.08 per cent and 6.15 per cent of respondents belonged ‘small’, ‘semi-medium’ and ‘medium’ category respectively.

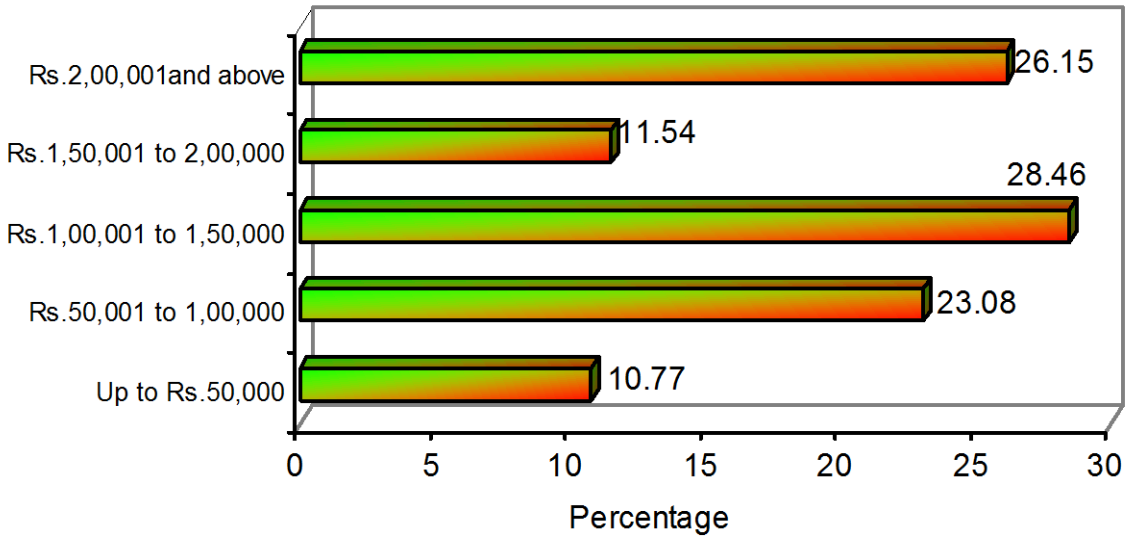
The average land holding of the tomato growers was 1.61 hectares. The data, indicated that a large proportion of respondents were ‘marginal’ and ‘small farmers. Therefore, while recommending IPM practices, one has to consider this aspect of the farming community.

The findings of the present study are in line with findings of Kashyp (2000), Pawar (2002), Ghadge (2005) and Bodke (2003).

### 4.1.4. Annual income

Income is a major determinant of the economic status of an individual. Every individual's living standards was decided to a great extent by his income. The expenditure on farming, allied occupation and household matters is decided by the income of the farmers. Thus, income level influences the degree of the farmers' prestige in the society and his contacts with the outside world. A low level of annual income hinders acquisition of new skills and knowledge needed for modem farming. A better financial position enables a farmer to be more enterprising in trying out IPM practices. Keeping this point in view the respondent were grouped into five categories and presented in Table 1.

**Fig. 4. Distribution of tomato growers according to their annual income**



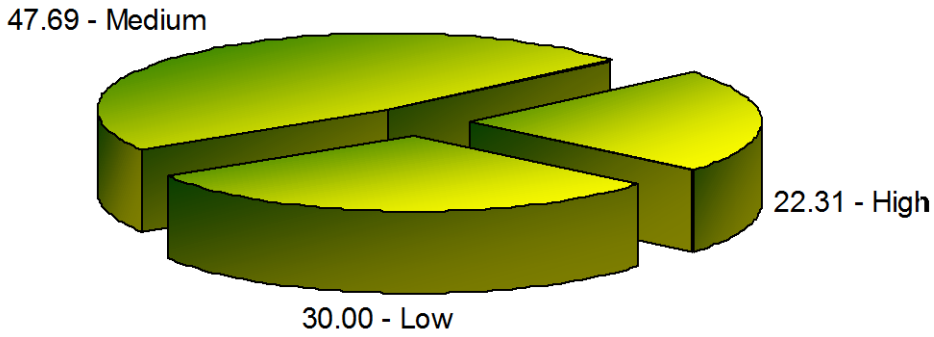

The data presented in the Table 1. indicated that, majority t of respondents i.e. 28.46 per cent had the annual income between Rs. 1,00,000 to 1,50,000, about 23.08 percent having income more than Rs. 2,00,001. However, 23.08 per cent had income between Rs. 50,001 to 1,00,000. The 11.54 per cent and 10.77 per cent of respondent had annual income between Rs. 1,50,001 to 2,00,000 and up to Rs. 50,000 respectively. The average annual income of the respondents was Rs. 1,64,000.

The findings of the present study are in line with the findings of Ghadge (2005), Chikhale *et al* (1996) and Anonymous (2002).

### 4.1.5. Social participation

Participation in different social organizations definitely influences one way of thinking, acting and also in behaving. It will be seen that more social participation by the elderly person from the family there was greater influence on other family member also, It is seen that the more the dissemination of innovation considering this facts the level of Social Participation distributed in Low, Medium, and high social participation group as shown in Table 1.

**Fig. 5. Distribution of tomato growers according to their social participation.**



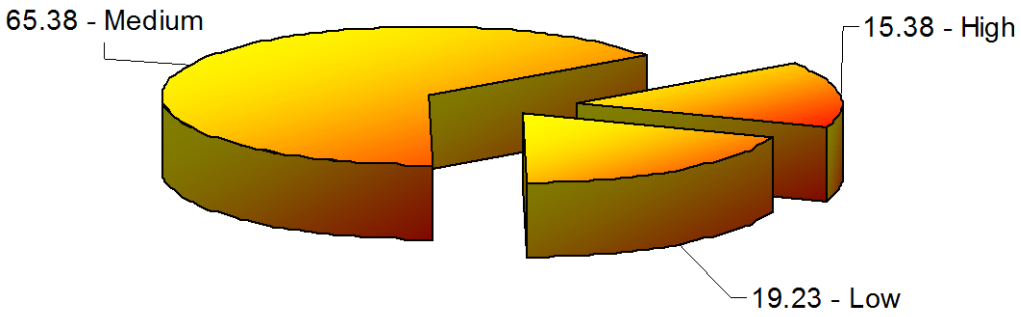

It is seen from the Table 1. that, the 47.69 per cent of the respondents had ‘medium’ social participation, while 30.00 and 22.31 per cent of the respondents were from ‘low’ and ‘high’ social participation category, respectively, The average social participation score of the respondents was 3.48.

The findings of the study are similar to Chikhale (1996), Borse (2002) and Patil (1995).

### 4.1.6. Sources of information

The farmers are keeping frequent contacts to the extension agencies, group contacts and mass media source to obtain more knowledge about latest technology. The sources of farm information used by farmer are categorized in the following three categories, namely low, medium and high as shown in Table 1.

**Fig. 6. Distribution of tomato growers according to their source of information.**




It is apparent from the Table 1. that, nearly two third (65.38 per cent) of the respondents were exposed to various source of farm information to the 'medium' level. The 19.23 per cent of the respondents had access to various source of farm information to the 'lower extent' and only 15.38 per cent of the respondents found to have used source of information for acquisition of information about IPM technology in tomato to the 'higher extent'.

The findings of the study are conformity with the finding of Bhosale (2003), Ghadge (2005), Pawar (2002) and Padalkar (1996).

## 4.2. Knowledge about IPM technology

The information pertaining to knowledge level of tomato growers about IPM technology is presented in Table .2.

### 4.2.1. Overall knowledge level about IPM technology

The overall knowledge of the respondents in relation to recommended IPM practices of Tomato crop was assessed. For this purpose, knowledge schedule was used. As per the knowledge schedule, knowledge score of each respondent was calculated on the basis of score of the respondents. They were grouped into three categories. *Viz*, low, medium and high knowledge level as shown in Table 2.

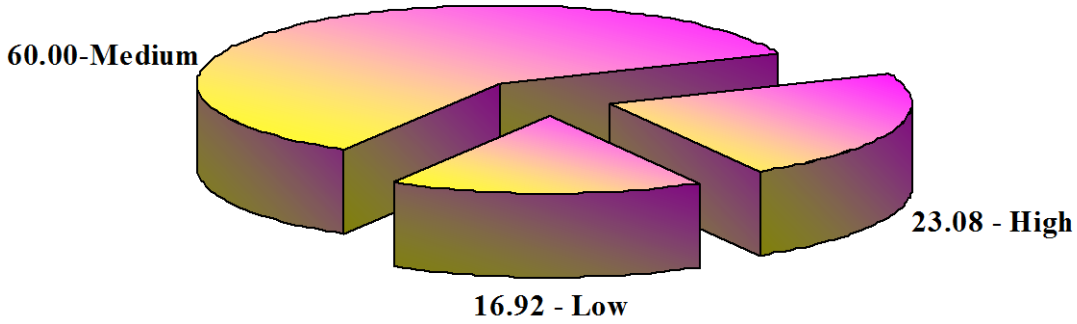
It is evident from the Table 2. that, three fifth (60.00 percent) of the respondents had in the 'medium' knowledge level group, while, 23.08 percent and 16.92 per cent of them had having 'high' and 'low' knowledge level, respectively. On an average the respondents exhibited the knowledge level score of 48.61.

**Table 2. Distribution of tomato growers according to their knowledge level about IPM technology**

| Sl. No. | Characteristic(s) | Respondents (n=130) | |
|---|---|---|---|
| | | Number | Percentage |
| **Overall knowledge level about IPM technology** | | | |
| i. | Low (up to 34 score) | 22 | 16.92 |
| ii. | Medium (35 to 60 score) | 78 | 60.00 |
| iii. | High (61 and above score) | 30 | 23.08 |
| **Total** | | **130** | **100.00** |
| **Average (score)** | | | **48.61** |
| **Head wise knowledge level about IPM technology** | | | |
| **I** | **Cultural practices** | | |
| i. | Low (Up to I7 score) | 13 | 10.00 |
| ii. | Medium (18 to 21 score) | 95 | 73.08 |
| iii. | High (22 and above score) | 22 | 16.92 |
| **Total** | | **130** | **100.00** |
| **Average (score)** | | | **20.3** |
| **II** | **Mechanical practices** | | |
| i. | Low (Up to 3 score) | 26 | 20.00 |
| ii. | Medium (4 to 9 score) | 83 | 63.85 |
| iii. | High (10 and above score) | 21 | 16.15 |
| **Total** | | **130** | **100.00** |
| **Average (score)** | | | **6.9** |
| **III.** | **Biological practices** | | |
| i. | Low (Up to 2 score) | 29 | 22.31 |
| ii. | Medium (3 to 11 score) | 73 | 56.15 |
| iii. | High (12 and above score) | 28 | 21.54 |
| **Total** | | **130** | **100.00** |
| **Average (score)** | | | **6.67** |
| **IV.** | **Chemical practices** | | |
| i. | Low (Up to 10 score) | 33 | 25.38 |
| ii. | Medium (11 to 18 score) | 47 | 36.15 |
| iii. | High (19 and above score) | 50 | 38.47 |
| **Total** | | **130** | **100.00** |
| **Average (score)** | | | **14.8** |

Thus, it can be said that the knowledge level of majority of the respondents was satisfactory. This might be due to the fact that the most of the farmers might have been exposed to the practices of IPM technology for longer period.

**Fig. 7. Distribution of tomato growers according to their overall knowledge (Percentage)**




This finding is in conformity with the findings of Chavai (2005), Ghadge (2005), Chapke (2000), Patel (2001), Veeraiah R. *et al. (2005)* and Borse (2003). However, the findings are not in conformity with the results of Anonymous (2001) and Bhople *et al.* (2001).

### 4.2.2. Headwise knowledge level of tomato growers

The information pertaining to knowledge of respondents about the recommended practices was grouped under four major heads Viz., cultural, mechanical, biological and chemical practices and is depicted in Table 2.

#### 4.2.2.1 Cultural practices

The data in Table 2. showed that around three forth i.e. 73.08 per cent of the respondents had 'medium' knowledge about cultural practices of IPM. While, 16.92 per cent and only 10.00 per cent respondents had 'high' and 'low' knowledge about cultural practices of IPM, respectively. The average knowledge level score of the respondents about cultural practices was 20.3. The finding is in conformity with the findings of Chavai (2005), Ghadge (2005), Kalaskar, *et al* (1999) and Borse (2003). However, the findings is not in conformity with the findings of Bhople, *et al.* (2001).

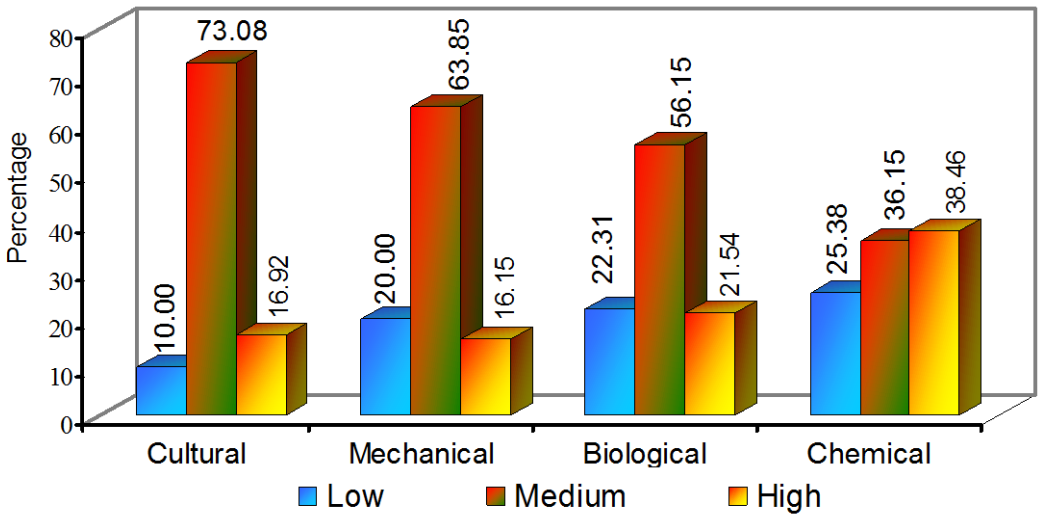
#### 4.2.2.2 Mechanical practices

The data in Table 2. revealed that, majority (63.85 per cent) of the respondents had 'medium' knowledge about mechanical practices of IPM technology. However, 20.00 per cent and I6.15 percent respondents had 'low' and 'high' knowledge about mechanical practices of IPM technology

respectively. The average knowledge level score of the respondents about mechanical practices was 6.9.

The findings are consistent with the observations made by Borse (2003), Kalaskar, *et al* (2001), Ghadge (2005), Chavai (2005). However, the findings are not consistent with the findings of Pitrubhakta (2001).

**Fig. 8. Distribution of tomato growers according to their head wise knowledge**




### 4.2.2.3. Biological Practices

The observations in Table 2. indicated that, more than half ( 56.15 per cent) of the respondents had medium knowledge. 22.31 and 21.54 per cent of respondents had 'low and high' level of knowledge of biological practices, respectively. The average knowledge score of respondents about biological practices was 6.67.

The findings are in line with the Borse (2003), Aghav (1997), Chapke (2000), Patel (2001), and Ghadge (2005). However the findings are not in conformity with the findings of Bhopale *et al.* (2001).

### 4.2.2.4. Chemical practices

The 38.47 per cent of the respondents had 'high' knowledge about Chemical Practices. However, 36.15 percent and 25.38 per cent the respondents had 'medium' and 'low' knowledge about chemical practices of IPM, respectively. The average knowledge level score of the respondents under this head was 14.8. The findings are conformity with the findings of Chapke (2000), Chavai (2005), Ghade (2005) and Katole (1996). The findings are not in conformity with findings of Anonymous (1996) and Borse (2003).

### 4.2.3. Practice wise knowledge level of tomato growers

The Table 3. revealed that the cultural practices which were known to almost all the respondents were timely removal and destruction of tomato stubbles and burning the residues (99.23 per cent), deep ploughing (100 per cent ), avoid sole cropping of tomato (89.23 per cent), crop rotation (93.08 per cent) staking in tomato (100.00 per cent), avoid excess irrigation (100 per cent) and weeding (100.00 per cent). With regards to mechanical practices, uprooting and destruction of diseased plant part (100.00 per cent), use of bird perches (85.38 per cent), collection and destruction of diseased leaves and fruits (88.46 per cent).

As regards with the biological practices of IPM of tomato, use of Phule Trichocard (93.84 per cent), release of *Chrysoperla* (65.38 per cent), avoid spray of toxic insecticides to conserve the Bio-agents (90.77 per cent) application of HaNPV (77.69 per cent), application of Bt (40.00 per cent), and NSKE (99.23 per cent), seed treatment with *Trichoderma viridi* (95.38 per cent). With regards to the chemical practices, judging the ETL level of the pests (72.31 per cent), spraying the insecticide when pests can cross ETL level (66.92 per cent), seedling treatment (97.69 per cent), spaying Malathion (98.46 per cent).

The respondents, however, were lacking in knowledge about some of important practices like, grazing of sheep and animals (72.31 per cent), avoid excess dose of nitrogenous fertilizer (73.84 per cent) inter cropping with marigold (58.46 per cent) of cultural practices. As regards with the Mechanical practices, as burning of paddy straw for control of nematodes (56.92 per cent), mulching of nursery bed with polythene sheet (36.15 per cent), use of light traps (51.54 per cent), use of sticky pans (47.69 per cent), fermentation of pulp for obtaining disease free seed (20.76 per cent) and hot water treatment (13.85 per cent).

The respondents are lacking knowledge about the biological practices viz., cutting the Trichocard having 10-20 eggs (20.77 per cent), spraying of Bt @ 1 to 1.5 lit./ha. (40 per cent) Delfin or Halt (47.69 per cent). In chemical practices the respondents were lacking knowledge about ETL

**Table.3. Distribution of tomato growers according to practice wise knowledge of IPM technology**

| Sl. No. | Recommended Practices of *INTEGRATED PEST MANAGEMENT (IPM)* technology on *tomato*. | Respondents | | | |
|---|---|---|---|---|---|
| | | Yes | | No | |
| | | Number. | % | Number. | % |
| ***A.*** | ***CULTURAL PRACTICES*** | | | | |
| **1** | **Clean up Campaign** | | | | |
| i. | Grazing of Sheeps or animals immediately after last harvesting of tomato. | 94 | 72.31 | 36 | 27.69 |
| ii. | Timely removal and destruction of tomato stubbles & burning the residues | 129 | 99.23 | 1 | 0.77 |
| iii. | Do not stock diseased plant material near the field | 120 | 92.31 | 10 | 7.69 |
| **2** | Deep ploughing to expose and destroy the soil hibernating stages of pest | 130 | 100.00 | 0 | 0.00 |
| **3** | Avoid sole cropping of Tomato | 116 | 89.23 | 14 | 10.77 |
| **4** | Crop rotation with solences family crops | 121 | 93.08 | 9 | 6.92 |
| **5** | Use of recommended pest tolerant hybrid varieties. | 115 | 88.46 | 15 | 11.54 |
| **6** | **Time of sowing / planting** | | | | |
| i. | Kharif - July | 114 | 87.69 | 16 | 12.31 |
| ii. | Rabi - September and October | 65 | 50.00 | 65 | 50.00 |
| iii. | Summer - Jan and Feb. | 121 | 93.08 | 9 | 6.92 |
| **7** | **Field layout & spacing** | | | | |
| i. | Ridges & furrows 90cm*30cm | 130 | 100.00 | 0 | 0.00 |
| **8** | **Intercropping** | | | | |
| i. | Intercropping with cowpea, maize, marigold | 121 | 93.08 | 9 | 6.92 |
| ii. | Planting of castor around tomato plot | 103 | 79.23 | 27 | 20.77 |
| iii. | Two rows of marigold after every 15 rows of tomato | 76 | 58.46 | 54 | 41.54 |
| **9** | **Application of fertilizer** | | | | |
| a. | Avoid high dose of nitrogenous fertilizer | 96 | 73.85 | 34 | 26.15 |
| b. | Recommended dose of fertilizer | | | | |
| | **For common varieties** | | | | |
| i. | Before transplanting 100:100:100 | 117 | 90.00 | 13 | 10.00 |
| ii. | 30 days after transplanting | 125 | 96.15 | 5 | 3.85 |
| | **For hybrid varieties** | | | | |
| i. | Before transplanting 150:150:150 | 112 | 86.15 | 18 | 13.85 |
| ii. | After transplanting 150:100:100 3 application after every 30 days interval | 129 | 99.23 | 1 | 0.77 |
| **10** | **Special care** | | | | |
| i. | Removal of alternate host from plot | 117 | 90.00 | 13 | 10.00 |
| ii. | Staking imediately after flowering with the help of bamboo & *sutali* | 130 | 100.00 | 0 | 0.00 |
| iii. | First weeding after 20-25 days | 130 | 100.00 | 0 | 0.00 |
| iv. | Avoid excessive irrigation & give only need based irrigations | 130 | 100.00 | 0 | 0.00 |
| ***B.*** | ***MECHANICAL/ PHYSICAL PRACTICES.*** | | | | |
| **1** | Collection & destruction of diseased leaves & fruits. | 115 | 88.46 | 15 | 11.54 |
| **2** | Uprooting & destruction of plant affected by bacterial wilt | 130 | 100.00 | 0 | 0.00 |
| **3** | Burnning of paddy straw for control of nematodes in nursery | 74 | 56.92 | 56 | 43.08 |
| **4** | Mulching field & remove the leaves up to 25 cm from ground | 86 | 66.15 | 44 | 33.85 |
| **5** | Use of 4 to 5 pheromone traps per Acer | 91 | 70.00 | 39 | 30.00 |
| **6** | Mulching of nursery beds by using 100 gauge polythene paper for 2 to 4 weeks | 47 | 36.15 | 83 | 63.85 |
| **7** | Use of 4 light traps per Acer | 67 | 51.54 | 63 | 48.46 |
| **8** | Use of 5 to 7 bird perches per Acer | 111 | 85.38 | 19 | 14.62 |
| **9** | Use of yellow sticky pan for control of white fly. | 62 | 47.69 | 68 | 52.31 |
| **10** | Fermentation of seed pulp for obtain disease free seed for 72 hrs. | 27 | 20.77 | 103 | 79.23 |
| **11** | Hot water ($50^0$C) seed treatment for 25 minutes for obtaing virus free seed | 18 | 13.85 | 112 | 86.15 |
| **12** | Covering of nursery bed with 100 mesh nylon net | 72 | 55.38 | 58 | 44.62 |

| | | | | | |
|---|---|---|---|---|---|
| ***C.*** | ***BIOLOGICAL PRACTICES*** | | | | |
| **1** | ***Use of Trichogramma prestisomus*** | | | | |
| i. | Use of Phule Tricocard 5 per ha. | 122 | 93.85 | 8 | 6.15 |
| ii. | Staple the card below leaves surface to avoid sunlight effect | 120 | 92.31 | 10 | 7.69 |
| ii. | Use 1 lakh eggs per ha. | 122 | 93.85 | 8 | 6.15 |
| **2** | **Use of *Chrysoperla*** | | | | |
| i. | Release of 10,000 eggs per ha. twice at 15 days interval | 85 | 65.38 | 45 | 34.62 |
| ii. | Cut the card card having 10-20 eggs per strip | 27 | 20.77 | 103 | 79.23 |
| iii. | Staple the card below leaves surface to avoid sunlight effect | 120 | 92.31 | 10 | 7.69 |
| iv. | The eggs of *chrysoperla* are green in colour and naturally appear singly on the stem of plant. | 95 | 73.08 | 35 | 26.92 |
| **3** | Avoid toxic insecticide spray for conserve bio-agent. | 118 | 90.77 | 12 | 9.23 |
| **4** | **Application of HaNPV for fruit borer** | | | | |
| i. | Spray HaNPV @ 250 LE / Ha. | 101 | 77.69 | 29 | 22.31 |
| ii. | HaNPV affected larvae turns dark & seen hanging downside on top of plant | 87 | 66.92 | 43 | 33.08 |
| iii. | Collection of diseased larva & spray 250 larval extract in 500 lit. water for ha. | 75 | 57.69 | 55 | 42.31 |
| **5** | ***Bacillus thuringiensis* (Bt) spray** | | | | |
| i. | Spray Bt culture @ 1 to 5 lit per Ha. | 52 | 40.00 | 78 | 60.00 |
| ii. | Spray Delfin or Holt @ 1.0 kg. per Ha. At 15 days interval | 62 | 47.69 | 68 | 52.31 |
| **6** | Spray 5% NSKE @ 2.0 per lit. | 129 | 99.23 | 1 | 0.77 |
| **7** | Seed treatment of *Trichoderma viridi* @ 4 gm Per Kg. seed | 124 | 95.38 | 6 | 4.62 |
| ***D.*** | ***CHEMICAL PRACTICES*** | | | | |
| **1** | **Judging economic threshold level (ETL)** | | | | |
| i. | Determination of ETL by recording selected 20-24 tomato plants. | 94 | 72.31 | 36 | 27.69 |
| ii. | Recording periodical observations about the incidence of pests | 116 | 89.23 | 14 | 10.77 |
| **2** | **ETL of pests** | | | | |
| i. | Aphids -10 nymphs/ leaf | 125 | 96.15 | 5 | 3.85 |
| ii. | Jassids - 2 to 3 / leaf | 120 | 92.31 | 10 | 7.69 |
| iii. | Thrips - 10/ leaf | 47 | 36.15 | 83 | 63.85 |
| iv. | Mites - 20 to 25 / leaf | 26 | 20.00 | 104 | 80.00 |
| v. | White fly - 10 / leaf | 102 | 78.46 | 28 | 21.54 |
| vi. | Fruit borer - 7 larva / 20 plants or 2-3 eggs / plant or 8-9 adults / pheromone trap | 125 | 96.15 | 5 | 3.85 |
| **3** | Spray the insecticide only when the pest crosses ETL. | 87 | 66.92 | 43 | 33.08 |
| **4** | Seed treatment - Thirum 3 gms or Carbofuran 30 gms or Trichoderma 5 gms / Kg. of seed. | 125 | 96.15 | 5 | 3.85 |
| **5** | Seedling treatment with Emidochloride 2ml + Carbofuran 20ml or 5% NSKE + 50 gms Trichoderma in 10 lit. for 3 hrs. before transplanting. | 127 | 97.69 | 3 | 2.31 |
| **6** | Application of Carbofuran 3G @ 30 to 40 gms per bed (2mX1m) or spray Dimethoate 10ml or mithyldemeton 10ml / 10lit. After 2 weeks. | 120 | 92.31 | 10 | 7.69 |
| **7** | Spray Trizophos 20 ml / 10 lit. if incidence of white fly above 10 percent | 112 | 86.15 | 18 | 13.85 |
| **8** | Spray Melethion 50EC @ 250 ml in 250 lit. if eggs of Helicoverpa seen on merigold plant | 128 | 98.46 | 2 | 1.54 |
| **9** | Spray 5% NSKE or Tricophos @ 20ml per lit. if incidence of leaf minor is above 10 per cent. | 127 | 97.69 | 3 | 2.31 |
| **10** | Spray Sulpher 80% WP @ 1 to 1.5 Kg / 500 lit. of water for effective control of mites an powdery mildew. | 107 | 82.31 | 23 | 17.69 |
| **11** | Spray Melethion 50EC or Dimethoate 30EC @1330ml in 500 lit./ha. For control of leaf curl disease vector white fly. | 112 | 86.15 | 18 | 13.85 |
| **12** | Application of Phorate 10G for control of Sucking pest complex which was ector of disease TMV. | 60 | 46.15 | 70 | 53.85 |
| **13** | Application of 5 kg Trichoderma (Phule tricoderma Plus) or Drenching of copper oxychoritde 20 gm / 10 lit. of water for effective control of wilt disease of Tomato. | 127 | 97.69 | 3 | 2.31 |

level of thrips (36.15 per cent), Mites (20.00 per cent), application of Phorate 10G for control of sucking pest complex (46.15 per cent)

The findings, thus, indicated that almost all the respondents knew the recommended practices which were followed by longer period, However, some of the very important recommendations having influence over pest management are not known to the respondents. It thus suggests that extension agency have to exert more to popularize these practices of IPM technology.

Most of the finding are consistent with the observations made by Chavai (2005), Ghadge (2005), Kalaskar *et al* (2001), Chapake (2000), Borse (2003) and Bhaivamkar *et al* (1998), However the finding are not consistent with findings of Bhopale *et al* (2001)

## 4.3. Adoption of IPM technology by tomato growers

The adoption of recommended IPM practices by the farmers is of prime importance. The IPM technology to get spread among the tomato growers to accelerate production level by efficient pest management. The IPM technology includes the cultural, mechanical, biological and need based chemical practices. The findings pertaining to overall adoption, major head wise adoption and practice wise adoption are presented in Table 4.

### 4.3.1. Overall adoption level of tomato growers

An adoption schedule was used for assessing the overall adoption. As per the adoption schedule, the adoption score of each respondent was calculated and converted into ‘Adoption Index’ i.e. percentage. On the basis of ‘Adoption Index range’, the respondents were grouped into three categories Viz. low, medium and high adoption as shown in Table 4.

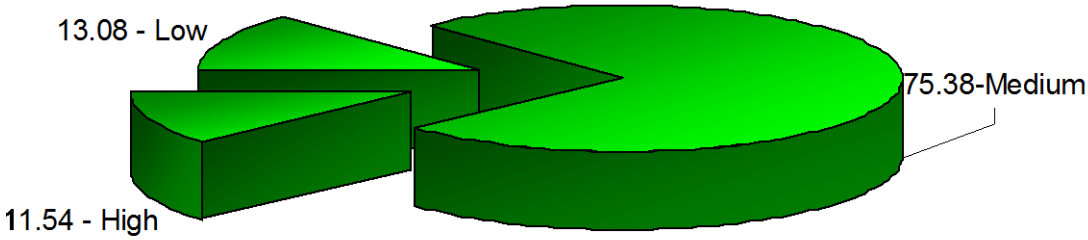
Table 4. indicated that, majority (75.38 per cent) of the respondents were in the ‘medium’ adoption category of recommended package of practices of IPM technology. The 13.08 percent of the respondents were adopted the recommended practices at ‘low’ level however, 11.54 per cent of respondents were in the ‘high’ adoption category of IPM technology. The average adoption of the respondents was 54.33 per cent. It is seen that there is much scope to increase adoption of IPM technology.

This finding is in conformity with the findings of Borse (2003), Chavai (2005) and Ghadge (2005).

**Table 5. Distribution of tomato growers according to their adoption level about IPM technology**

| Sr. No. | Characteristic(s) | Respondents (n=130) | |
|---|---|---|---|
| | | Number | Percentage |
| **Overall adoption level about IPM technology (Index range)** | | | |
| i. | Low (up to 35) | 17 | 13.08 |
| ii. | Medium (36 to 72) | 98 | 75.38 |
| iii. | High (73 and above) | 15 | 11.54 |
| **Total** | | **130** | **100.00** |
| **Average (Adoption Index)** | | | **54.33** |
| **Head wise adoption level about IPM technology** | | | |
| **I -** | **Cultural practices** | | |
| i. | Low (Up to24 score) | 17 | 13.08 |
| ii. | Medium (25 to 40 score) | 89 | 68.46 |
| iii. | High (41 and above score) | 24 | 18.46 |
| **Total** | | **130** | **100.00** |
| **Average (score)** | | | **32.9** |
| **II -** | **Mechanical practices** | | |
| i. | Low (Up to 4 score) | 25 | 19.23 |
| ii. | Medium (5 to 12 score) | 81 | 62.31 |
| iii. | High (13 and above score) | 24 | 18.46 |
| **Total** | | **130** | **100.00** |
| **Average (score)** | | | **8.49** |
| **III.** | **Biological practices** | | |
| i. | Low (Up to 1 score) | 27 | 20.77 |
| ii. | Medium (2 to 13 score) | 84 | 64.62 |
| iii. | High (14 and above score) | 19 | 14.61 |
| **Total** | | **130** | **100.00** |
| **Average (score)** | | | **7.01** |
| **IV** | **Chemical practices** | | |
| i. | Low (Up to 15 score) | 21 | 16.15 |
| ii. | Medium (16 to 33 score) | 85 | 65.38 |
| iii. | High (34 and above score) | 24 | 18.47 |
| **Total** | | **130** | **100.00** |
| **Average (score)** | | | **24.36** |

**Fig. 9. Distribution of tomato growers according to their overall adoption (Percentage)**




### 4.3.2. Head wise adoption of IPM technology by tomato growers

The data regarding head wise adoption of IPM technology *viz*. Cultural, Mechanical, Biological and Chemical practices by the respondents was given in Table 4.

#### 4.3.2.1 Cultural practices

The data in Table 4. indicated that, majority (68.46 per cent) of the respondents had ‘medium' adoption level, however 13.08 and 18.46 per cent of the respondents has ‘low’ and ‘high’ adoption level of cultural practices, respectively. The average adoption score of the respondents of cultural practices was 32.9. The findings are in line with the finding of Borse (2003), Chavai (2005), Robertson *et al*. (2005) and Patel (2001).

#### 4.3.2.2 Mechanical practices

The data shown in Table 4. indicated that, maximum percentage i.e. 62.31 per cent of the respondent had medium adoption, while 19.23 per cent and 18.46 per cent of the respondents had 'low' and 'high’ adoption of mechanical practices of IMP, respectively. The average adoption level score of the respondent of mechanical practices was 8.49.

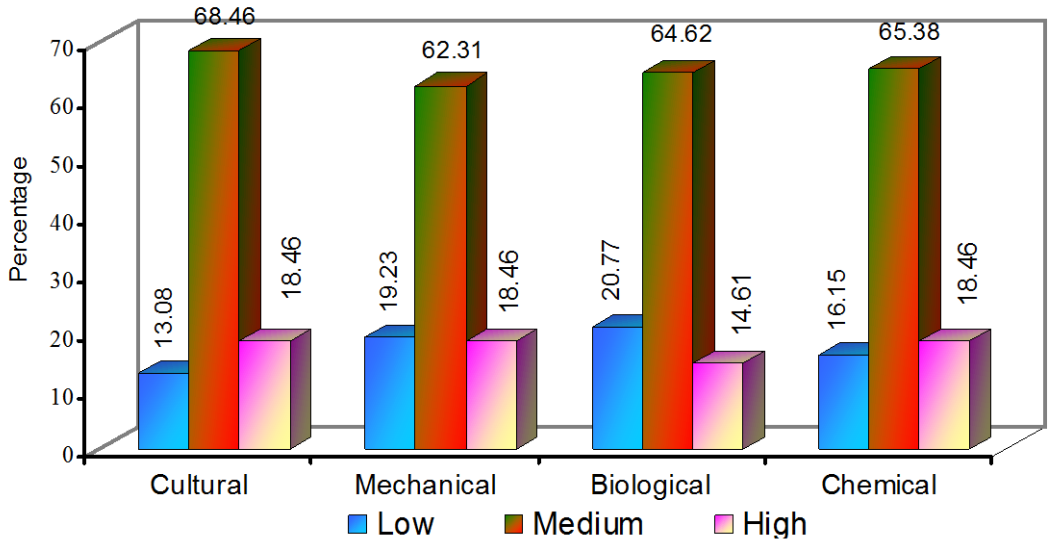
The findings are in conformity with the findings of Chavai (2005), Kalaskar (1999), and Robertson *et al.* (2005), However, the findings are not in conformity with the findings of shinde. *et al.* (1997) and Borse (2003).

#### 4.3.2.3. Biological practices

The data in Table 4 revealed that 64.62 per cent of the respondents had ‘medium' adoption, while 14.61 per cent of respondents had ‘high’ level of

adoption and about one fifth of the respondents i.e. 20.77 per cent of respondents having ‘low’ level of adoption of biological practices of IPM technology.

**Fig. 10. Distribution of tomato growers according to their head wise adoption**




The average adoption level score of the respondents of biological practices was 7.01.

The findings agree with the findings of Subharaidu (1993), Chapke (2000), Chavai (2005) and Kubade *et al* (1996). However, the findings do not agree with the findings of Katole et al (1996)

### 4.3.2.4 Chemical practices

It was observed from Table 4. that, majority of (65.38 per cent) the respondents had 'medium' level of adoption of chemical practices of IPM technology. However, 18.47 and 16.15 per cent of the respondent having ‘high’ and 'low' level of adoption practices of IPM technology respectively. The average adoption level score of the respondents of chemical practices was 24.36

The findings are in line with the findings of Borse (2003) and Chavai (2005) and Ghadge (2005), however the findings are not in line with the findings of Kalaskar *et al* (2001).

## 4.3.3. Practice wise adoption level of tomato growers

Practice wise knowledge and adoption of recommended IPM practices by the tomato growers according to their adoption level are depicted in Table 5.

**Table.3. Distribution of tomato growers according to practice wise Adoption of IPM technology**

| Sl. No. | Recommended Practices practices of *INTEGRATED PEST MANAGEMENT (IPM)* Technology on *TOMATO*. | Adoption | | | | | |
|---|---|---|---|---|---|---|---|
| | | Complete | | Partial | | No | |
| | | No | % | No | % | No | % |
| ***A.*** | ***CULTURAL PRACTICES*** | | | | | | |
| **1** | **Clean up Campaign** | | | | | | |
| i. | Grazing of Sheeps or animals immediately after last harvesting of tomato. | 38 | 29.23 | 8 | 6.15 | 84 | 64.62 |
| ii. | Timely removal and destruction of tomato stubbles & burning the residues | 123 | 94.62 | 7 | 5.38 | 0 | 0.00 |
| iii. | Do not stock diseased plant material near the field | 97 | 74.62 | 14 | 10.77 | 19 | 14.62 |
| **2** | Deep ploughing to expose and destroy the soil hibernating stages of pest | 130 | 100.00 | 0 | 0.00 | 0 | 0.00 |
| **3** | Avoid sole cropping of Tomato | 97 | 74.62 | 33 | 25.38 | 0 | 0.00 |
| **4** | Crop rotation with solences family crops | 107 | 82.31 | 19 | 14.62 | 4 | 3.08 |
| **5** | Use of recommended pest tolerant hybrid varieties. | 128 | 98.46 | 2 | 1.54 | 0 | 0.00 |
| **6** | **Time of sowing / planting** | | | | | | |
| i. | Kharif - July | 99 | 76.15 | 21 | 16.15 | 10 | 7.69 |
| ii. | Rabi - September and October | 89 | 68.46 | 28 | 21.54 | 13 | 10.00 |
| iii. | Summer - Jan and Feb. | 106 | 81.54 | 20 | 15.38 | 4 | 3.08 |
| **7** | **Field layout & spacing** | | | | | | |
| i. | Ridges & furrows 90cm*30cm | 130 | 100.00 | 0 | 0.00 | 0 | 0.00 |
| **8** | **Intercropping** | | | | | | |
| i. | Intercropping with cowpea, maize, marigold | 89 | 68.46 | 24 | 18.46 | 17 | 13.08 |
| ii. | Planting of castor around tomato plot | 23 | 17.69 | 45 | 34.62 | 62 | 47.69 |
| iii. | Two rows of marigold after every 15 rows of tomato | 28 | 21.54 | 35 | 26.92 | 67 | 51.54 |
| **9** | **Application of fertilizer** | | | | | | |
| a. | Avoid high dose of nitrogenous fertilizer | 21 | 16.15 | 63 | 48.46 | 46 | 35.38 |
| b. | Recommended dose of fertilizer | | | | | | |
| | **For common varieties** | | | | | | |
| i. | Before transplanting 100:100:100 | 47 | 36.15 | 60 | 46.15 | 23 | 17.69 |
| ii. | 30 days after transplanting | 119 | 91.54 | 11 | 8.46 | 0 | 0.00 |
| | **For hybrid varieties** | | | | | | |
| i. | Before transplanting 150:150:150 | 99 | 76.15 | 20 | 15.38 | 11 | 8.46 |
| ii. | After transplanting 150:100:100 3 application after every 30 days interval | 104 | 80.00 | 26 | 20.00 | 0 | 0.00 |
| **10** | **Special care** | | | | | | |
| i. | Removal of alternate host from plot | 115 | 88.46 | 12 | 9.23 | 3 | 2.31 |
| ii. | Staking imediately after flowering with the help of bamboo & *sutali* | 130 | 100.00 | 0 | 0.00 | 0 | 0.00 |
| iii. | First weeding after 20-25 days | 130 | 100.00 | 0 | 0.00 | 0 | 0.00 |
| iv. | Avoid excessive irrigation & give only need based irrigations | 114 | 87.69 | 16 | 12.31 | 0 | 0.00 |
| ***B.*** | ***MECHANICAL/ PHYSICAL PRACTICES.*** | | | | | | |
| **1** | Collection & destruction of diseased leaves & fruits. | 106 | 81.54 | 13 | 10.00 | 11 | 8.46 |
| **2** | Uprooting & destruction of plant affected by bacterial wilt | 130 | 100.00 | 0 | 0.00 | 0 | 0.00 |
| **3** | Burnning of paddy straw for control of nematodes in nursery | 13 | 10.00 | 30 | 23.08 | 87 | 66.92 |
| **4** | Mulching field & remove the leaves up to 25 cm from ground | 14 | 10.77 | 60 | 46.15 | 56 | 43.08 |
| **5** | Use of 4 to 5 pheromone traps per Acer | 10 | 7.69 | 39 | 30.00 | 81 | 62.31 |
| **6** | Mulching of nursery beds by using 100 gauge polythene paper for 2 to 4 weeks | 8 | 6.15 | 34 | 26.15 | 88 | 67.69 |
| **7** | Use of 4 light traps per Acer | 9 | 6.92 | 56 | 43.08 | 65 | 50.00 |
| **8** | Use of 5 to 7 bird perches per Acer | 47 | 36.15 | 63 | 48.46 | 20 | 15.38 |
| **9** | Use of yellow sticky pan for control of white fly. | 4 | 3.08 | 34 | 26.15 | 92 | 70.77 |
| **10** | Fermentation of seed pulp for obtain disease free seed for 72 hrs. | 0 | 0.00 | 2 | 1.54 | 128 | 98.46 |
| **11** | Hot water ($50^0$C) seed treatment for 25 minutes for obtaing virus free seed | 0 | 0.00 | 0 | 0.00 | 130 | 100.00 |
| **12** | Covering of nursery bed with 100 mesh nylon net | 0 | 0.00 | 37 | 28.46 | 93 | 71.54 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***C.*** | ***BIOLOGICAL PRACTICES*** | | | | | | |
| **1** | ***Use of Trichogramma prestisomus*** | | | | | | |
| i. | Use of Phule Tricocard 5 per ha. | 48 | 36.92 | 68 | 52.31 | 14 | 10.77 |
| ii. | Staple the card below leaves surface to avoid sunlight effect | 48 | 36.92 | 68 | 52.31 | 14 | 10.77 |
| ii. | Use 1 lakh eggs per ha. | 48 | 36.92 | 68 | 52.31 | 14 | 10.77 |
| **2** | **Use of *Chrysoperla*** | | | | | | |
| i. | Release of 10,000 eggs per ha. twice at 15 days interval | 39 | 30.00 | 62 | 47.69 | 29 | 22.31 |
| ii. | Cut the card card having 10-20 eggs per strip | 27 | 20.77 | 83 | 63.85 | 20 | 15.38 |
| iii. | Staple the card below leaves surface to avoid sunlight effect | 48 | 36.92 | 68 | 52.31 | 14 | 10.77 |
| iv. | The eggs of *chrysoperla* are green in colour and naturally appear singly on the stem of plant. | | | | | | |
| **3** | Avoid toxic insecticide spray for conserve bio-agent. | | | | | | |
| **4** | **Application of HaNPV for fruit borer** | | | | | | |
| i. | Spray HaNPV @ 250 LE / Ha. | 88 | 67.69 | 29 | 22.31 | 13 | 10.00 |
| ii. | HaNPV affected larvae turns dark & seen hanging downside on top of plant | | | | | | |
| iii. | Collection of diseased larva & spray 250 larval extract in 500 lit. water for ha. | 4 | 3.08 | 22 | 16.92 | 104 | 80.00 |
| **5** | ***Bacillus thuringiensis* (Bt) spray** | | | | | | |
| i. | Spray Bt culture @ 1 to 5 lit per Ha. | 16 | 12.31 | 59 | 45.38 | 55 | 42.31 |
| ii. | Spray Delfin or Holt @ 1.0 kg. per Ha. At 15 days interval | 29 | 22.31 | 48 | 36.92 | 53 | 40.77 |
| **6** | Spray 5% NSKE @ 2.0 per lit. | 96 | 73.85 | 19 | 14.62 | 15 | 11.54 |
| **7** | Seed treatment of *Trichoderma viridi* @ 4 gm Per Kg. seed | 107 | 82.31 | 14 | 10.77 | 9 | 6.92 |
| ***D.*** | ***CHEMICAL PRACTICES*** | | | | | | |
| **1** | **Judging economic threshold level (ETL)** | | | | | | |
| i. | Determination of ETL by recording selected 20-24 tomato plants. | 68 | 52.31 | 60 | 46.15 | 2 | 1.54 |
| ii. | Recording periodical observations about the incidence of pests | 100 | 76.92 | 30 | 23.08 | 0 | 0.00 |
| **2** | **ETL of pests** | | | | | | |
| i. | Aphids -10 nymphs/ leaf | 107 | 82.31 | 21 | 16.15 | 2 | 1.54 |
| ii. | Jassids - 2 to 3 / leaf | 80 | 61.54 | 26 | 20.00 | 24 | 18.46 |
| iii. | Thrips - 10/ leaf | 19 | 14.62 | 12 | 9.23 | 99 | 76.15 |
| iv. | Mites - 20 to 25 / leaf | 10 | 7.69 | 16 | 12.31 | 104 | 80.00 |
| v. | White fly - 10 / leaf | 45 | 34.62 | 47 | 36.15 | 38 | 29.23 |
| vi. | Fruit borer - 7 larva / 20 plants or 2-3 eggs / plant or 8-9 adults / pheromone trap | 107 | 82.31 | 16 | 12.31 | 7 | 5.38 |
| **3** | Spray the insecticide only when the pest crosses ETL. | 39 | 30.00 | 59 | 45.38 | 32 | 24.62 |
| **4** | Seed treatment - Thirum 3 gms or Carbofuran 30 gms or Trichoderma 5 gms / Kg. of seed. | 94 | 72.31 | 26 | 20.00 | 10 | 7.69 |
| **5** | Seedling treatment with Emidochloride 2ml + Carbofuran 20ml or 5% NSKE + 50 gms Trichoderma in 10 lit. for 3 hrs. before transplanting. | 112 | 86.15 | 18 | 13.85 | 0 | 0.00 |
| **6** | Application of Carbofuran 3G @ 30 to 40 gms per bed (2mX1m) or spray Dimethoate 10ml or mithyldemeton 10ml / 10lit. After 2 weeks. | 120 | 92.308 | 10 | 7.69 | 0 | 0.00 |
| **7** | Spray Trizophos 20 ml / 10 lit. if incidence of white fly above 10 percent | 127 | 97.692 | 3 | 2.31 | 0 | 0.00 |
| **8** | Spray Melethion 50EC @ 250 ml in 250 lit. if eggs of Helicoverpa seen on merigold plant | 130 | 100.00 | 0 | 0.00 | 0 | 0.00 |
| **9** | Spray 5% NSKE or Tricophos @ 20ml per lit. if incidence of leaf minor is above 10 per cent. | 125 | 96.15 | 2 | 1.54 | 3 | 2.31 |
| **10** | Spray Sulpher 80% WP @ 1 to 1.5 Kg / 500 lit. of water for effective control of mites an powdery mildew. | 128 | 98.46 | 2 | 1.54 | 0 | 0.00 |
| **11** | Spray Melethion 50EC or Dimethoate 30EC @1330ml in 500 lit./ha. For control of leaf curl disease vector white fly. | 122 | 93.85 | 8 | 6.15 | 0 | 0.00 |
| **12** | Application of Phorate 10G for control of Sucking pest complex which was ector of disease TMV. | 91 | 70.00 | 26 | 20.00 | 13 | 10.00 |
| **13** | Application of 5 kg Trichoderma (Phule tricoderma Plus) or Drenching of copper oxychoritde 20 gm / 10 lit. of water for effective control of wilt disease of Tomato. | 112 | 86.15 | 12 | 9.23 | 6 | 4.62 |

The data in Table 5. indicted that, the cultured practices adopted by almost all the respondents were namely, deep ploughing (100 per cent), timely removed and destruction of stubbles (94.62 per cent), crop rotation (82.31 per cent) use of recommended pest tolerant verities/hybrids (94.61 per cent), field layout i.e. spacing (100 per cent), stacking (100 per cent), weeding (100 per cent), with regards to cultural practices like uprooting and destructions of plant affected bacterial wilt (100 per cent), collection and destruction of disease leaves and fruits (81.54 per cent), use of bird perches (36.15 per cent)

In regards with the biological practices seed treatment with *Trichoderma Viridi* (82.80 per cent), spray *NSKE* (73.84 per cent), use of C*hrysoperla* (36.92 per cent). Regarding chemical practices the majority of the farmers are adopted all the practices viz., application of carbofuron (92.30 per cent), spray of Trizophos (97.69 per cent), spray of Melathion (100 per cent), spray of sulphor (98.46 per cent), spray of NSKE (96.15 per cent) and application of phorate 10G (70 per cent)

However, some of the respondents are not adopting the some of the important practices of IPM technology at full extent as, grazing of sheep and goat(29.23per cent) caster plantation around plot (17.69 per cent), avoid high dose of nitrogenous fertilizer (16.15 per cent) as cultural practices, while with regards of mechanical practices burning of paddy straw (10.00 per cent), use of pheromone traps (7.69 per cent) use of sticky pans (3.08.per cent). None of the respondents were adopting the practices like fermentation, hot water treatment and covering nursery beds with nylon net.

The biological practices as like cutting the egg cards (20.77 per cent), collection of diseased larva and spray 250 LE of HaNPV(3.08 per cent), spray Bt (12.31 per cent). With respect to chemical practices ETL of mites, thrips, (14.62 per cent) are the some practices that were adopted at lower extend.

These findings are in conforming with the findings of the Chavai (2005), Ghadge (2005) and Kalaskar *et al*. (2001).

## 4.4. Relationship between the selected independent variables and adoption level of IPM technology

To ascertain the relationship between tomato growers' extent of adoption of IPM technology and their selected characteristics, the correlation coefficient test was applied. On the basis of operational measures developed for the variables, hypotheses were stated for testing the relationship and their significance on correlation. The correlation coefficient between adoption and various independent variables *Viz.,* personnel and socio-economic characteristics are presented in Table 6.

**Table 6. Relationships between adoption level and selected Personnel and socio-economic characteristics of the respondents**

| Sl.No. | Independent Variables | Correlation Coefficient 'r' with adoption |
|---|---|---|
| **1** | Age | -0.5719** |
| **2** | Education | 0.6146** |
| **3** | Annual Income | 0.4822** |
| **4** | Land Holding | 0.1814* |
| **5** | Social Participation | 0.1933* |
| **6** | Source of Information | 0.4279** |
| **7** | Knowledge | 0.8382** |

**- Significant at 1 per cent d. f. = 0.231 at 1 per cent.
*- Significant at 5 per cent d. f. = 0.177 at 5 per cent.

### 4.4.1. Age and adoption

The correlation coefficient (r= -0.5719) indicates that the relationships between the age and adoption level of tomato growers was negative and significant.

It was observed from Table 6 that the adoption of recommended practices of IPM technology was not influenced by the age of the tomato growers. Thus, the hypothesis that the adoption level of tomato growers related to age is rejected. The findings of the study are similar with the Deshmukh (1996), Sutar (1997) and Vidhate (1997). However, the findings are not consistant to the findings of Ghadge (2005), Borse (2002) and Bodke (2003)

### 4.4.2. Education and Adoption

The relationship between education and adoption level of the respondents was found to be positively significant (r=0.6145).

Education helps an individual to acquire more knowledge, understand better and inclined to get correct information for use in farming. The farmer's orientation towards scientific farming may increase due to education, which leads them to increase production by adoption of modern agricultural production techniques like IPM technology of tomato. More education might have resulted increase in knowledge level which might have contributed for more adoption of IPM technology in tomato. Thus the hypothesis that the adoption level of IPM technology of tomato growers related to education is accepted. This finding is in conformity with the findings of Chavai (2005), Chapake (2000), Ghadge (2005) and Pawar (2002).

### 4.4.3. Annual income and adoption

The annual income of the respondents exhibited positive and significant relationship (r= 0.4822) with their adoption level of IPM technology of Tomato.

This might be due to the fact that, the respondents with sound economic position might be more capable to procure inputs needed for the adoption of practices of IPM technology of tomato without much difficulty. Also farmers having high levels of income prefer to take risks of accepting the recommended farm techniques. Thus, the hypothesis that the adoption level of tomato growers related to annual income is accepted

The findings of the study are supported by the result of Chavai (2005), Ghadge (2005), Bhosale (2002) and Kalaskar *et al* (1999).

### 4.4.4. Land holding and adoption

Relationship between land holding and adoption level of various practices of IPM technology of tomato was positive and significant at 5 per cent (r= 0.1814) and non-significant at 1 per cent level of probability.

It can be inferred that farmers with large size of landholding have higher socio-economic status, have more risk orientation and higher social participation. This might have led to accept new ideas earlier and adopt modern technology on their farm. This is probably the reason for the positive

significant relationship. Thus, the hypothesis that the adoption level of tomato growers related to land holding was accepted. The results are similar to Chavai (2005), Ghadge (2005) Borse (2003) and Pawar (2002). However, the results are not similar to result obtained by Nagpurkar (1997).

### 4.4.5 Social participation and adoption

There is a positive and significant relationship between social participation and adoption (r= 0.193) at 5 per cent level and non-significant at 1 per cent level of probability.

It was observed that the adoption of recommended practices of IPM technology was influenced by the social participation of the tomato growers. It means that adoption level increased with increase in social participation. Thus, the hypothesis that the adoption level of tomato growers related to social participation was accepted. The findings of study are supported by the results of Deshmukh (1996) and Kulkarni (1999).

### 4.4.6. Source of information and adoption

A positive and highly significant relationship was found between source of farm information used and adoption of IPM technology (r= 0.4278).

Extent of use of sources of farm information is one of the important aspects for adoption of innovations in agriculture. It is relieved that with increased use of sources of farm information used by the tomato growers, there was an increase in their adoption level of IPM technology. Thus the hypothesis that the adoption level of tomato growers related to source of information was accepted.

This finding is in line with the findings reported by Kalaskar *et al.* (1999), Kharat (2001), Ghadge (2005) and Borse (2002)

### 4.4.7. Knowledge and adoption of IPM technology

The correlation coefficient (r= 0.8381) indicates that the relationships between knowledge and adoption level of IPM technology was positive and highly significant.

There was a positive relationship between knowledge and adoption of IPM technology. As the knowledge about IPM technology was increases the adoption of IPM technology is also increases. The knowledge is helpful for farmer to knowing about an innovation that helps them to make decision

about adopting such innovation on the farm. The Knowledge about the innovations was helpful for the adoption of such innovations in agriculture. Thus, the hypothesis that the adoption level of tomato growers related to knowledge about IPM technology was accepted.

The findings of the study was similar to the Vasava (1997), Bhujbal (1998), Bhagwan singh (2004) and Shinde (1997)

## 4.5. Constraints faced by tomato growers in adoption of IPM technology and their suggestions.

### 4.5.1. Constraints faced in adoption of IPM technology by tomato growers

To study the constraints faced by the tomato growers in adoption of IPM technology was one of the main objective of the present study. The constraints are the circumstances or causes that prohibit and restraints the farmers in adoption of the recommended technology. There are some farmer who are always ahead in adoption of certain innovations while other do not. The thrust of the present investigation was to know why the tomato growers do not adopt IPM technology for pest control in tomato and what are the constraints those prohibit them from adoption of IPM technology are given in Table 7.

From Table 7 it is observed that, 82.31 per cent of the tomato growers had faced the constraints about unavailability of the pest and disease resistance improved varieties, 40 per cent of the tomato growers had problem of skilled labour while 30 per cent of tomato grower had problem of irrigation water. Majority of the tomato grower faced the problem of the high cost of fertilizers, pesticides, fungicides and bio-pesticides.

Half (50.77 per cent) of the tomato growers faced the constraints of lack of availabity of the spraying and dusting equipment and more cost of packaging material was 57.69 per cent. 61.54 per cent of the tomato growers were faced the problem of inadequate and untimely supply of the loan for tomato cultivation and also high interest rate of the loan is about 70.77 per cent.

**Table 7. Constraints faced by tomato growers while adopting IPM technology**

| Sl. No. | Constraints | Respondents (n=130) | |
|---|---|---|---|
| | | Frequency | Per cent |
| 1 | High cost of fertilizer, pesticides, fungicides and bio-pesticide | 111 | 85.38 |
| 2 | Unavailability of pest & disease resistant improved seed material | 107 | 82.31 |
| 3 | Fluctuation in the market price of tomato | 107 | 82.31 |
| 4 | Uncontrolled commission rate of middle man | 106 | 81.54 |
| 5 | High interest rate on crop loan | 92 | 70.77 |
| 6 | Inadequate and untimely supply of loan for tomato cultivation | 80 | 61.54 |
| 7 | Lack of knowledge and skill of identification of pest diseases | 76 | 58.46 |
| 8 | More cost of packaging material | 75 | 57.69 |
| 9 | Lack of availability of spraying and dusting equipments | 66 | 50.77 |
| 10 | Non-availability of skilled labour | 52 | 40.00 |
| 11 | Lack of availability of Information Booklets and Books in local languages (*Marathi*) | 42 | 32.31 |
| 12 | Lack of availability of irrigation water | 39 | 30.00 |

It is observed from Table 7 that 58.46 per cent of the farmers have the lack of the knowledge and skill of identification of pest and disease, 32.31 per cent of the farmers faced the problem of lack information booklets and book about integrated pest management in local language (*Marathi*). Majority of the farmers (81.54 per cent) were faced the problem of uncontrolled commission rate of the middleman, 82.31 per cent farmer faces the major problem like fluctuation of tomato market price.

## 4.5.2. Suggestions of tomato growers

Considering the constraints experienced by the tomato growers in recommended practices for integrated pest management in tomato they were asked to offer the suggestions to over come the constraints. The suggestions made by the tomato grower are presented in Table 8.

**Table 8. Suggestions by tomato growers to overcome the constraints while Adopting IPM technology**

| Sl. No. | Suggestions | Respondents (n=130) | |
|---|---|---|---|
| | | Frequency | Per cent |
| 1 | Bio-pesticides, pheromone traps & light traps should be available in low price & at local place | 112 | 86.15 |
| 2 | Low interest rate on crop loans | 109 | 83.85 |
| 3 | Plant protection equipment should be available in time at reasonable rate | 99 | 76.15 |
| 4 | Loan should be available in time | 97 | 74.62 |
| 5 | Providing the subsidy for IPM | 80 | 61.54 |
| 6 | Disease & pest forecasting from State Department & Argil Universities | 78 | 60.00 |
| 7 | Conducting the guidance project (group discussion, demonstration) for IPM | 73 | 56.15 |
| 8 | High market price for the products produced by IPM technology other than normal production. | 57 | 43.85 |
| 9 | Literature should be available in local language | 42 | 32.31 |

In present investigation 32.31 per cent of the tomato growers are suggested that the literature made available in local (Marathi) language and 76.15 per cent suggested that the plant protection equipments should be made available in time and at reasonable rate. Disease and pest forecasting from the State Department and Agricultural Universities was suggested by 60 per cent of the farmer also conducting the programs like group discussion and demonstrations on IPM (56.15 per cent)

Half 56.15 per cent of the tomato growers suggested that the high price for the tomato produced from the IPM plots than ordinary plot. 74.62 per cent of tomato growers suggested that loan should be made available in time and 84 per cent suggested interest on loans should be low.

Majority of the tomato growers (86.15 per cent) suggested that low price and availability at the local place of the pesticides, pheromones trap and light trap 61.54 per cent of the tomato growers were suggested that providing the subsidy for integrated pest management

# 5. Summary, Conclusions And Implications

IPM technology for pest control in various crops had assumed special significance now days. Tomato (*Lycopersicon esculentum* Mill*.)* is one of the most important 'Protective Foods' both because of its special nutritive value and also because of its wide spread production. However, it is most susceptible for insect pest, which leads to the practice of indiscriminate use of chemical pesticides for control of insect pest. It leads to the problem of pest resistance to chemical pesticides, risk to human and animal health and environmental pollution because of this the plant protection specialists especially agricultural entomologist are presently engaged in development of more compatible measures for sustainable agriculture. Integrated pest management (IPM) alternative evolved by the scientist for effective pest control in tomato and other crops. But still it is observed that farmers do not adopt these practices to the largest extent.

The present investigation was, therefore, planned to know the extent of adoption of IPM technology by the tomato growers and to know the constraints behind non-adoption of IPM technology by them.

**5.1 Objectives of the study**

1. To study personal and socio-economic characteristics of the Tomato Growers.
2. To study the knowledge of Integrated Pest Management (IPM) technology of the Tomato Growers.
3. To study the adoption of Integrated Pest Management (IPM) technology of the Tomato Growers.
4. To study relationship between the selected characteristics of the Tomato Growers with their adoption.
5. To study the constraints faced by the Tomato Growers in adoption of IPM technology and the suggestions made by them to overcome the constraints.

**5.2 Methodology**

The study was conducted in Haveli Tahsil of Pune District. Ten villages were selected which having maximum area under the tomato

cultivation. The respondents were selected by key information method. The data were collected by interviewing the respondents personally with the help of a specially designed and structured interview schedule. The data were then tabulated, analyzed and interpreted.

## 5.1. Summary

The summary of the important findings is described here under

### 5.1.1. Personal and socio-economic characteristics

a) The 43.85 per cent of tomato growers were belongs to 'young' age group followed by 'middle' (31.54 per cent) and 'old' (24.62 per cent) age group respectively. Thus, it can be inferred that large population of tomato growers belonged to 'young' age group followed middle and then old. It was noted that the average age of tomato grower was 41years.

b) The 82.31 per cent of the respondents had received education. The proportion of respondents who received 'secondary education' was largest (33.85 per cent) while, 29.23 per cent of the respondent received 'primary education'. The 19.23 per cent of the respondents are received the 'college education' and about 17.69 per cent are the 'illiterate'. The average education of the respondent was 8$^{th}$ standard.

c) The 39.23 per cent of the respondents were 'marginal farmers' who possessed land 1.00 hectares. However, 31.54 per cent, 23.08 per cent and 6.15 per cent of the respondents belonged 'small' and 'semi-medium' and 'medium' category respectively. The average land holding of the tomato growers was 1.61 hectares.

d) The 28.46 per cent of respondents are having the annual income between Rs. 1,00,000 and 1,50,000, 23.08 percent having income more than Rs. 2,00,001. However, 23.08 per cent having income between Rs. 50,001 and 1,00,000. The 11.54 per cent and 10.77 per cent of respondent having annual income between Rs 1,50,001 and 2,00,000 and up to Rs. 50,000 respectively. The average annual income of the respondents was Rs. 1,64,000.

e) The 47.69 per cent of the respondents had 'medium' social participation, while 30.00 and 22.31 per cent of the respondents were from 'low' and 'high' social participation category, respectively. The average social

participation score of the respondents was 3.48

f) The majority of the respondents (65.38 per cent) were exposed to various sources of farm information to the ‘medium’ level. The 19.23 per cent of the respondents had access to various sources of farm information to the ‘lower extent’ and only 15.38 per cent of the respondents found to have used sources of information for acquisition of information about IPM technology in tomato to the ‘higher extent’.

### 5.3.2. Knowledge of tomato growers about IPM technology.

#### 5.3.2.1. Overall Knowledge level of tomato growers.

The majority (60.00 percent) of the respondents were in the ‘medium’ knowledge level group. While, 23.08 percent and 16.92 per cent of them were having ‘high’ and ‘low’ knowledge level, respectively. The average knowledge level score of respondents was 48.61.

#### 5.3.2.2. Head wise Knowledge level of tomato growers

a) The 73.08 per cent of the respondents had ‘medium’ knowledge about cultural practices of IPM. While, 16.92 per cent and only 10.00 per cent respondents had ‘high’ and ‘low’ knowledge about cultural practices of IPM. The average knowledge level score of the respondents about cultural practices was 20.3.

b) The majority (63.85per cent) of the respondents had ‘medium’ knowledge. However, 20.00 per cent and I6.15 per cent of the respondents had ‘low’ and ‘high’ knowledge about mechanical practices of IPM. The average knowledge level score of the respondents about mechanical practices was 6.9.

c) The more than half (i.e. 56.15 per cent) of the respondents had medium knowledge. While, 22.31 and 21.54 per cent of respondents had low and high level of knowledge of biological practices, respectively. The respondents having 6.67 knowledge level score of biological practices on an average.

d) The 38.46 per cent of the respondents had ‘high’ knowledge about chemical practices. However, 36.15 percent and 25.38 per cent the respondents had ‘high’ and ‘low’ knowledge about chemical practices of IPM, respectively. The average knowledge level score of the respondents

under this head was 14.8.

### 5.3.2.3. Practice wise knowledge level of tomato growers

a) The cultural practices which were known to the respondents were timely removal and destruction of tomato stubbles and burning the residues(99.23 per cent), deep ploughing (100 per cent ), avoid sole cropping of tomato (89.23 per cent), crop rotation (93.08 per cent) staking in tomato (100.00 per cent), weeding (100.00 per cent).
b) With regards to mechanical practices, uprooting and destruction of diseased plant part (100.00 per cent), use of bird perches (85.38 per cent), collection and destruction of diseased leaves and fruits (88.46 per cent).
c) In case of the biological practices of IPM of tomato, use of trichocard (93.84 per cent), release of *Chrysoperla* (65.38 per cent), avoid spray of toxic insecticides to conserve the bio-agents (90.76 per cent) application of HaNPV (77.69 per cent), application of Bt (40.00 per cent), and NSKE (99.23 per cent), seed treatment with *Trichoderma viridi* (95.38 per cent).
d) With regards to the chemical practices, judging the ETL level of the pests (72.30 per cent), spraying the insecticide when pests can cross ETL level (66.92 per cent), seedling treatment (97.69 per cent), spaying malathion (98.46 per cent).

## 5.3.3. Adoption of tomato growers about IPM technology.

### 5.3.3.1. Overall adoption level of tomato growers.

The majority (75.38 per cent) of the respondents were in the ‘medium’ adoption category of recommended package of practices of IPM technology. The 13.08 percent of the respondents were adopted the recommended practices at ‘low level.’ However, 11.54 per cent of the respondents were in the ‘high’ adoption category of IPM technology. The average adoption of the respondents was 54.33 per cent.

### 5.3.3.2. Head wise adoption level of tomato growers

a) The majority (68.46 per cent) of the respondents had ‘medium' adoption level, however 13.08 and 18.46 per cent of the respondents has ‘low’ and ‘high’ adoption level of cultural practices, respectively. The average adoption score of the respondents of cultural practices was 14.8.

b) The maximum percentage i.e. 62.31 per cent of the respondent had 'medium' adoption, while 19.23 per cent and 18.46 per cent respondents had 'low' and 'high' adoption of mechanical practices of IMP. The average adoption level score of the respondent of mechanical practices was 8.49.

c) The 64.62 per cent of the respondents had 'medium' adoption, while 14.62 per cent of respondents had 'high' level of adoption and about one fifth of the respondents i.e. 20.77 per cent of respondents having 'low' level of adoption of biological practices of IPM technology. The average adoption level score of the respondents of biological practices was 7.01.

d) The majority of (65.38 per cent) of respondents had 'medium' level of adoption of chemical practices of IPM technology. However, 18.46 and 16.15 per cent of the respondent having 'high' and 'low' level of adoption practices of IPM technology. The average adoption level score of the respondents of chemical practices was 24.36

**5.3.3.3. Practice wise adoption level of tomato growers**

a) The cultural practices adopted by almost all the respondents were viz. deep ploughing (100 per cent) timely removed and destruction of stubbles (99.42 per cent) crop rotation (82.80 per cent) use of recommended pest tolerant verities/hybrids (94.61 per cent), field layout i.e. spacing (100 per cent) stacking (100 per cent) and weeding (100 per cent).

b) The Mechanical practices like uprooting and destructions of plant affected bacterial units (100 per cent), collection and destruction of disease leaves and fruits (81.53 per cent), use of bird purchase (36.15 per cent)

c) In regards with the biological practices seed treatment with *trichoderma viridi* (82.80 per cent), spray NSKE (73.84 per cent) use of C*hrysoperla* (36.92 per cent).

d) The chemical practices the majority of farmers are adopted all the practices viz., application of carbofuron (92.30 per cent), spray of trizophos (97.69 per cent), spray of melathion (100 per cent), spray of sulphor (98.46 per cent), spray of NSKE (96.15 per cent), application of phorate 10G (70 per cent).

**5.3.4 Relationship between selected independent and dependent variables**

The tomato growers' characteristics age had exhibited negative and significant relationship with adoption of IPM technology. Others variables namely education, annual income, sources of information and knowledge exhibited positive and significant relationship with their Adoption level of IPM technology at 0.01 level of probability. However land holding and social participation exhibited positive and significantly association with adoption level at 0.05 level of probability.

## 5.3.5. Constraints and suggestions

### 5.3.5.1. Constraints

The 85.38 per cent of the tomato growers faced the problem of high cost of the fertilizers, pesticides and bio-pesticides, 82.31 per cent of the tomato growers faced the constraint viz., unavailability of pest and diseases resistant improved seed material and also of fluctuation, The market price of tomato, 81.54 per cent of the tomato growers faced constraints of uncontrolled commission rate of middle man. The 70.77 per cent of tomato growers faced constraint of high interest rate on crop loan.

### 5.3.5.2. Suggestions

The majority of tomato growers (86.15 per cent) suggested that the bio-pesticides, pheromone traps and light traps should be made available at low price and at local place, and 83.85 per cent of tomato growers were suggested that there should be low rate of interest on crop loans. About three fourth 76.15 per cent of tomato growers suggested that plant protection measures should be available in time at reasonable rate. 74.62 per cent of the farmers suggested that loan should be available in time and 61.54 per cent of the tomato growers suggested to provide the subsidy for IPM.

## 5.3 Conclusion

### 5.4.1. Personal and socio-economic characteristics

It was found that tomato growers having education upto secondary level, marginal land holding, annual income between Rs. 1,00,001 to 1,50,000, medium social participation, medium source of information and having medium knowledge level were the adapters of IPM technology at medium level on tomato.

### 5.4.2. Adoption of IPM technology

It was found that majority of the tomato growers (75.38 per cent) had medium adoption level about overall adoption of IPM technology of tomato. The tomato growers also had medium level of adoption about cultural, mechanical, biological and chemical practices of the IPM technology on tomato.

It was observed that majority of tomato growers adopted recommended practices like timely removal and destruction of stubbles, deep ploughing, crop rotation, use of recommended pest tolerant varieties/hybrids, spacing, stacking, weeding, uprooting and destruction of plant affected by bacterial wilt, Use of bird perches, seed treatment with *trichoderma viridi*, spray NSKE, use of Chrysoperla, application of carbofuron, spray of Trizophos, melathion, sulpher and phorate.

However, very low adoption was found in respect of the practices *viz.,* grazing of sheep and goats, caster plantation around plot, avoid high dose of nitrogenous fertilizer, burning of paddy straw for sterilization of land, use of pheromone traps, sticky pans, cutting the eggs cards of *Trichogramma spp*, collection of diseased larva and spray of 250 LE of HaNPV, spray Bt, and ETL of mites, thrips. The respondents adopt the practices like fermentation, hot water treatment and covering nursery beds with nylon net. at low level.

### 5.4.3. Relationship between selected independent and dependent variables

It is concluded that with the increased level of education, annual income, land holding, social participation, sources of information and knowledge about IPM technology, their level of adoption of IPM technology also increased. Relationship between age and adoption level of IPM technology was negative and significant.

It was also concluded that education, annual income, source of information and level of knowledge could contribute more to variation in adoption of IPM technology.

### 5.4.4. Constraints faced by tomato growers

The important constraints reported by considerable number of tomato growers were high cost of fertilizers, pesticides, fungicides and bio-agents, unavailability of pest and disease resistant improved seed material, fluctuation in market price, uncontrolled commission rate of middle man and high interest rate of loans for tomato cultivation.

### 5.4.5. Suggestions made by tomato growers

The important suggestions made by tomato grower were availability of bio-pesticides, pheromone traps and light traps at reasonable rate at local place, plant protection equipment should be available in time at reasonable cost, loan should be available in time providing the subsidy to IPM, disease and pest forecasting from State Agriculture Department and State Agricultural Universities.

## 5.5. Implications

The author hopes that this research study would be highly useful in understanding personal and socio-economic characteristics of the tomato growers, their knowledge and adoption level about IPM technology and constraints faced by them in adoption of IPM technology and suggestions made by them. The result of the study would provide guideline to policy makers, executors and the extension agents, in popularizing the IPM technology among farmers. On the basis of the results of the present study, following implication have been drawn.

### 5.5.1 Action implications

1) The study has identified the tomato growers' knowledge level of IPM technology. On the basis of these findings, the extension personnel may locate the clients for training on IPM and also those who can be used as counselors to other farmers.
2) The study has also identified the tomato growers adoption of IPM technology. The extension personal may use these findings for locating the prospective adopters and increase the rate of adoption of IPM technology.
3) The tomato growers were found to be in lacking in detail knowledge about HaNPV, Bt, *Trichogramma spp*, pest tolerant varieties, pheromone traps, light traps, judging of ETL for the pest control. Therefore, farmers' training in IPM technology will be very useful to increase adoption of IPM technology in tomato.
4) The availability of bio-agents of pest control, pheromone traps and light traps should be available on large scale at reasonable cost by Department of Agriculture.
5) Maximum literature, poster, charts and folders should be published and distributed by Department of Agriculture with consultation of scientists from Agricultural universities.
6) The campaign programs should be organized jointly by Agricultural University and Department of Agriculture for adoption of IPM technology.

### 5.5.2. Research implication

The present study being exploratory type, the findings will have to be tested in other parts of the state, having similar agro-ecological and socio economical, psychological situation of respondents on large scale.

The investigation made it clear that variation in the adoption level of IPM technology was explained by the independent variables selected for the study. The future researchers may try to find out the factors responsible for remaining variation.

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# VITA

## MR. SHETE DATTA NARAYAN

*A Candidate for Degree of*

## Master of Science (Agriculture)
## In
## AGRICULTURAL EXTENSION.

Title of thesis :- **Study on Adoption of Integrated Pest Management (IPM) technology in Tomato.** (*Lycopersicon esculentum Mill.*)

Major field :- **Agricultural Extension.**

### Biographical information

Personal data : - Born at Malthan, Tal-Daund, Dist-Pune, on November 19, 1981, Son of Sau. Satyabhama & Shri. Narayan Rau Shete.

### Educational Qualification

- Passed S. S. C. examination from Loknayak Jay Prakash Narayan Vidyalaya, Khed, Tal-Karjat, Dist.-Ahmednagar in 1998 with first class.
- Passed H. S. C. examination from Dada Patil Mahavidyalaya, Karjat Dist.-Ahmednagar. in 2000 with second class.
- Completed B. Sc. Agriculture degree at College of Agriculture, Kolhapur, Mahatma Phule Krishi Vidyapeeth, Rahuri, in 2004 with first class.

**Present Address** :- At-Maljainagar, Post-Khed, Tal-Karjat, Dist- Ahmednagar, Pin-414403.
Ph. No. 02489-257256(R)
Mobile. 93250 14711
*e-mail:-* datta.shete@gmail.com, datta.s@rediffmail.com