Survey on Insecticide Use Pattern of Vegetable Growers in Raipur District Of Chhattisgarh

M. Sc. (Ag.) THESIS

By

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Survey on Insecticide Use Pattern of Vegetable Growers in Raipur District Of Chhattisgarh

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CERTIFICATE-I

This is to certify that the thesis entitled **"Survey On Insecticide Use Pattern Of Vegetable Growers In Raipur District Of Chhattisgarh"** submitted in partial fulfillment of the requirements for the degree of "**MASTER OF SCIENCE IN AGRICULTURE"** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **Shri KATEKAR HARISH PAVAN** under my guidance and supervision. The subject of the thesis has been approved by Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigation have been duly acknowledged by him.

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CERTIFICATE-II

This is to certify that the thesis entitled **"Survey On Insecticide Use Pattern Of Vegetable Growers In Raipur District Of Chhattisgarh"** submitted by **Shri KATEKAR HARISH PAVAN** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur in partial fulfillment of the requirements for the degree of "**M.Sc. (Ag.)"** in the **Department of Entomology** has been approved by the external examiner and Student's Advisory Committee after oral examination.

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LIST OF ABBREVIATIONS

ABBREVIATION	DESCRIPTION
%	Per cent
@	At the rate of
^{O}C	Degree celsius
mg	Mili grams
MRL	Maximum residue limit
Wt	Weight
et al.	And other
Fig.	Figure
g.	Gram
cfu	Colony forming unit
/	Per
i.e.	That is
kg	Kilo gram
No.	Number
viz.	Namely

CHAPTER - I

INTRODUCTION

India has a wide variety of climate and soils on which a range of vegetable crops can be grown. During the last two decades considerable emphasis has been laid on production of vegetable crops, as a result of it vegetable exports have been stepped up (CHADDA, 2000).

In commercial cultivation vegetable crops are grown intensively; sometimes even two or more crops are taken in a season. Introduction of high yielding technology creates microclimatic conditions which favours the rapid multiplication of insect pest and diseases. However for controlling these losses excessive and indiscriminate use of pesticides not only increases the cost of production but also results in many human health problems and environmental pollution. According to WHO estimates, one million cases of pesticide poisoning occur every year and consequently there are 20000 deaths globally (Nasir, 1999). The most damaging ecological disturbance of injudicious use of pesticides is the existence of high concentration of pesticide residues in food chain, including cereals, pulses, vegetables, fruit, milk, milk products and water.

During the last five decades attempts were made to control the insect pest of vegetable effectively by use of various insecticides. As a result, more and more insecticides belonging to different groups have been developed and marketed in quick succession against insect pest of vegetable. The cultivars being highly impressed by the apparent advantages of the insecticides started using the same insecticide indiscriminately without caring for the side/ill effects of these poisonous chemicals.

Pesticides came in to extensive use in agriculture and public health as early as 1944. They are now used on fruits, vegetable and other crops on a massive scale. Benefits reflected in terms of enhanced farm productivity and control of vector borne diseases were so overwhelming that the real awakening to the problem of toxic residues left by pesticides come into sharp focus only around 1960. The problem of contamination of our food commodities; especially fruits and vegetable by pesticide residues constitutes one of the most serious challenges to public health. The hazards of toxic residues can be considerably reduced if pesticides are used in accordance with “good agricultural practice”. The information on the levels of pesticide residues occurring in food commodities is essential and can be obtained through regular monitoring procedures.

The extensive and indiscriminate use of these chemicals on vegetables posses serious residue problems, which are hazardous for human and animal health, natural enemies and for environment. Chahal, (1997) made an exhaustive monitoring study of insecticide residues in farmgate samples of vegetables in Punjab, a leading state in vegetable production. They reported that of the 96 samples of 10 different vegetables, 67 per cent were contaminated with over 10 kinds of insecticides residues. In 7 per cent samples of the vegetables (cauliflower, brinjal, cabbage, tomato), the residues were above the Maximum Residue Limit (MRL) values. It has been estimated that an average Indian ingested about 40 times more pesticide residues with food and water than the average Westerner Gupta, (2006). A survey conducted in U.P. and Hyderabad revealed that average pesticide intake through food were 0.29 and 0.36 mg/person/day, respectively Anonymous, (2004). Dethe *et al.* (1995) reported use of endosulfan, cypermethrin, dimethoate, monocrotophos and mancozeb more frequently than other pesticides and detectable residue were observed 33.3 per cent in tomato, 73.3 per cent in brinjal and 14.3 per cent in okra.

In studies conducted in India by the ICAR, New Delhi through its network of 17 All India Coordinated Research Projects (AICRPs) on Pesticide Residues during 1995 to 1998, it was found that of the over 4000 farmgate samples of vegetable monitored, 55% carried pesticide residues. Almost 9% of these were laden with pesticides above maximum permissible residue levels (MRL). During 2001, the ICAR sources reported 61% of the 712 vegetable samples analyzed contained pesticide residues, 11% of which exceeded the respective MRL values. In case of fruits, of the 378 samples of 12 different species analyzed, 53% were declared loaded with pesticide residues although their concentrations were largely within acceptable tolerance limits. Values. Taking an overall view, the ICAR and ICMR (Indian Council of Medical Research) New Delhi sources recorded that our food commodities were contaminated with a variety of pesticides, chiefly insecticides, to the extent of 50-60%, of which 14-20% were of above MRL values. Against it, the global average of pesticide residues and contamination in food commodities was estimated at 21%. A survey in U.P. and Hyderabad revealed that average pesticide intakes there through food were 0.27 and 0.36mg/ person/ day, respectively. These values were higher than the acceptable daily intake (ADI) of 0.025 mg pesticide/ kg body weight established for DDT by FAO/ WHO. The ICMR, while reviewing Pesticide Pollution in India, recorded people in several cities accumulated in their body fat, DDT and HCH in high concentration of 4.7 – 22.25 ppm and 1.43 – 16.85 ppm, respectively, from their food and environment. (ICMR, 2001). Thus the pesticide residue issues are enormously important to modern agriculture, it is necessary to create awareness among the vegetable growers for adopting good agricultural practices.

In view of the above situations a study was conducted with the following objectives:

1. **Survey on the plant protection knowledge of vegetable growers of Raipur region.**
2. **Seasonal abundance of vegetable insect pest at the farmer's field during Rabi season.**
3. **Status of insecticide residues in the farm gate sampling of vegetables.**

CHAPTER 2

REVIEW OF LITERATURE

This chapter deals with the brief account of research work done on the related aspects by various workers from the state, country and abroad. The literature pertaining to the present investigation entitled **"Survey on insecticide use pattern of vegetable cultivation in Raipur district of Chhattisgarh"** were collected and grouped under the following headings.

1. Survey on plant protection knowledge of vegetable growers.
2. Seasonal abundance of vegetable insect pest
3. Status of insecticide residues in the vegetables.

1. Survey on plant protection knowledge of vegetable growers

Kain (1998) reported that brinjal, okra and cabbage are the most adopted and kundru and torai are the least adopted vegetable crops of Chhattisgarh region. The major insect pest problem repoeted by the respondents are aphid on cabbage and field pea (90.9%) followed by brinjal fruit & shoot borer on brinjal and *Earias vitella* on okra. While tomato *Helicoverpa armigera* is the major problem i.e. 84.61% per cent respondents. The insecticides being used in the region against the major insect pest of vegetables are malathion (40.59%) followed by endosulfan, dimecron and nuvacron.

Khan (2005) reported that tomato, okra, brinjal, cauliflower, pea and onion these vegetables received insecticides most frequently in Peshawar. Cypermethrin (19.99%) followed by methamidophos (13.33%), chloropyriphos (12.41%), methomyl (10.52%), dimethoate (8.57%) and endosulfan (7.62%) are the commonly used insecticides on fruits and vegetables. Total fruit and vegetable samples (608) analyzed, 250 samples (41%) contained detectable residues; of which 13.8% had residues that exceeded maximum residue limits (MRLs).

2. Seasonal abundance of vegetable insect pest

Roy and Behura (1983) observed aphid insect infesting throughout the year on chilli, cotton, okra and reached peak numbers in September-November depending on weather. Crops were attacked at flowering and fruiting stages.

Parihar and Singh (1986) studied the larval population of *Helicoverpa armigera* on tomato and losses caused by this pest in Meerut district of Uttar Pradesh, in 1983-84 and 1984-85. The larval population was low till the first week of Feburary in both years and increased rapidly reaching a peak in the last week of March. In the last week of April the population declined to 4 larvae/plants. Percentage fruit infestation was low up to the end of Feburary; while in the second week of April 50.08 and 83.04 per cent of fruits were infested in 1984 and 1985, respectively. By the second week of May, 1.44 per cent of fruits were infested in 1984 and 2.84 per cent in 1985.

Kashyap and Bishnoi (1988) observed the appearance and build up of *Myzus persicae* populations during 1976-85 in Haryana. They reported that the relative humidity (66 $\pm$ 2.8%) and saturation deficit (2.53 $\pm$ 0.65 mm of Hg) were found to follow a normal curve for the population build up of *M. persicae.* Aphid population decreased sharply with increase of relative humidity (65%) and also with the linear increase in mean temperature. Aphid response pockets with optimum temperature (68-75%) were clearly demarcated.

Kandoria *et.al.* (1989) studied the seasonal activity and host range of *Aphis gossypii* in the Punjab from June 1986 to May 1987. They found that aphid was active throughout the year and recorded on 37 species of plants in 16 families, aphids was most active on chilli during October-November. The population of chilli thrips declined from May to the end of June due to high temperature.

Viraktamah *et.al.,* (1993) reported incidence of *Liriomyza trifolii* in Gujrat, Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, and Union territory of Delhi their report also revealed that tomato is a host for *Liriomyza trifolii.*

Baloch *et al*. (1994) observed the incidence and abundance of insect pests associated with chilli during the summer season 1993. They found four species of insect pests *Bemisia tabaci*, *Scritothrips dorsalis*, *Aphis gossypii* and *Amarasca devastans on chillies.*

Bagmare *et al.,* (1995) recorded the effect of weather parameters on the populations of *Liriomyza trifolli* on tomato and other hosts, in Jabalpur, Madhya Pradesh, India. The peak abundance of *Liriomyza trifolii* recorded during the month of January-Feburary. Correlation analysis of the variables showed that mean temperature and sunshine hours had a positive correlation with the population of *L. trifolii.* Rainfall and relative humidity had negative correlation with populations of *L. trifolii*.

Sivaprakasan (1996) investigated the effect of weather factors on the population dynamics of *H. armigera* in tomato field of T.N.A.U. India in 1991. The maximum temperature and relative humidity had the greatest positive effect in light trap catches.

Men *et al*., (1997) determined the influence of weather on the abundance of *Bemisia tabaci* on sunflower during the rabi season 1984-91 in Maharashtra. The peak abundance of *B. tabaci* occurred during December- January. There was a negative correlation between the maximum and minimum temperature, sunshine hours and pest abundance. A non significant positive correlation was found between morning and evening relative humidity and pest abundance.

Abdel *et al.,* (1998) observed the population dynamics of *Bemisia tabaci* and their relation with abiotic parameters in tomato, in Egypt during 1995-96. Temperature had a significant effect on both egg and nymphal populations. While relative humidity had non significant effect.

Kulat (1999) has reported chilli crops being severely infested by *Aphis gossypii* around Nagpur district of Maharashtra during January-Febeuary 1999, causing death of 20-25 per cent of the plants.

Ozawa *et al.,* (1999) observed the population growth rate of *Liriomyza trifolii,* on tomato which was highest at 25^{o}C, and female fecundity varied from 15^{o}C to 25 ^{o}C.

Suenaga *et al*., (1999) investigated the effect of low and high temperatures on the longevity and fecundity of pupae and adults of *Liriomyza trifolii.* Longevity and fecundity of the adults emerging from the pupae exposed to 15 ^{o}C to 30^{o}C were reduced at 25 ^{o}C compared with those of the adults emerging from the pupae exposed to 20 ^{o}C or 25 ^{o}C. The survival rate of the pupae and the adults were reduced at 30 ^{o}C than at 25 ^{o}C.

Chaudhari *et al*., (2001) studied the seasonal incidence and population density of *B. tabaci* on tomato (cv. Avinash-II) in West Bengal, India, during 1997 to 1998. The highest population density (1.68 white flies per plant) was observed during mid-Feburary. High infestation levels were maintained from mid-February to mid- March when temperature, relative humidity (RH), sunshine hour per day and rainfall were 17.07 ^{o}C-22.13 ^{o}C, 65.29-72.78 per cent, 7.79-8.9 hour per day and 5 mm, respectively.

Devi *et al.,* (2004) studied on the seasonal abundance and population dynamics of *Plutella xylostella* L. along with natural enemies in mid hill region of

Himachal Pradesh. They reported that pest appeared in February end and its population peaked in the mid April.

Reddy and Kumar (2004) carried out a study to record the pest complex on tomato at selected places of Chintamani (*Thummalahalli*, Singasandra and Kaiwara) and Kolar (Kembodi, Seethi and kannur) taluks of Kolar district, Karnataka, India, during 1998-99. A total of 41 insect species, belonging to 21 families, were recorded. These include the defoliators *Spodoptera litura*, *Monolepta andrawesi, Poekilocerus pictus* and *Atractomorpha crenulata* ,leaf miner *Liriomyza trifolii,* sucking insects *Bemisia tabaci, Aphis gossypii, Myzus persicae* and *Nezara viridula,* stem feeders *Eu*zophera perticella and *Leucinodes orbonalis and* fruit borers *Helicoverpa armigera and Otheris fullonica* (*Eudocima fullonica)* in which fruit borer, leaf miner and whitefly were major insect pest.

Kakati *et al*., (2005) conducted field experiment in Jorhat, Assam, India, during the 2001-02 in rabi season, to study seasonal history and population bhuild up of tomato fruit borer (*Helicoverpa armigera).* The pest population increase starting from the second week of December. The populations build up of the pest revealed significant negative correlation with low temperature and non-significant correlation with high temperature. Non-significant positive impact of relative humidity, total rainfall and bright sunshine hours was also recorded on tomato fruit borer incidence. High and low temperature, evening relative humidity and bright sunshine hours had non-significant positive impacts on per cent tomato fruit infestation.

Ready and Kumar (2005) determined the seasonal abundance of *Liriomyza trifolii* in a field experiment conducted in Karnataka, India during the *kharif* season of 1998-99. The peak incidence of *Liriomyza trifolii* was observed during March-April, which coincided with the vegetative and reproductive stages of the crop. The population declined in November-December is due to natural parasitization. A highly significant negative correlation between the seasonal abundance of the pest and mean rainfall (-0.6481 and -0.5863), total rainfall (-0.7206 and -0.6976) and number of rainy days (-0.7001 and -0.7114) was observed. A positive non-significant correlation between the seasonal abundance of the pest, and the maximum and minimum temperatures (0.1172 and 0.2648; 0.1193 and 0.2398, respectively) and morning and evening relative humidity (-0.2510 and -0.3258; -0.2601 and -0.3187, respectively) was observed.

Singh *et al*., (2005) reported that aphid (*Lipaphis erysimi* Kalt.) incidence commenced from third week of December and reached its peak in second to third week of February. After this population declining then vanished at the end of February to first week of March.

Verma *et al*., (2006) reported the highest intensity of brinjal shoot & fruit borer (*Leucinodes orbonalis* Guen.) during second week of December, when the damaged fruit was recorded 3.76 - 45.45 percent at Allahabad (Utter Pradesh).

Jandial and Kumar (2007) conducted field survey for 3 years (2001-03) to record the pest status of vegetable crops in Western Utter Pradesh. Fruit borer was the serious pest recorded to infest the tomato crop; other important pests are *B. tabaci, Aphis gossypii, Myzus persicae* and *Spodoptera litura*.

Sarkar *et al*., (2007) monitored the incidence pattern of *Plutella xylostella* (L.) and *Athalia lugens proxima* (Klug.) on two consecutive years on yellow sarson. The result revealed that both the pests were most abundant during January – February when the maximum and minimum temperature varied from 21^{o} C to 31.4^{o} C and 7.9^{o} C to 19.9^{o} C respectively.

Jain (2008) reported that jassid, aphid, white fly and brinjal shoot & fruit borer population were associated on late vegetative crop.

Singh and Pandita (2009) stated that the incidence of fruit borer in brinjal is highest in first and second picking followed by third and fourth picking with the least in fifth picking.

3. Status of insecticide residues in the vegetables.

Wallis *et al*. (1957) reported that malathion sprayed on okra fruit @ 0.05 percent was analyzed and the initial deposit 4.3 to 11.3 ppm reached below detectable level within 4 days after application of malathion.

Jat and Srivastava (1973) reported that malathion sprays of 0.05 percent @ 0.850 lit/ha on summer crop of okra provided initial deposit of 11.67 and 16.72 ppm on small, 3.20 and 10.39 ppm on medium and 2.58 and 4.63 ppm on normal marketable size of fruits. The residues dissipated rapidly and reached below the tolerance limit of 3 ppm on normal marketable fruits within 48 hours after the treatment. In normal marketable fruits development from medium and small size also, the residue was far below the tolerance limit of 3 ppm.

Kushwah and Pal (1978) found that the initial deposit of 0.2 per cent carbaryl (11.47 ppm) and 0.1 per cent endosulfan (5.91 ppm), on tomato fruits, after fourth spray, dissipated rapidly and the residues reached below tolerance limit of 5 ppm and 2 ppm respectively after 6 days of application.

Verma (1979) reported that endosulfan dissipated to 0.38 ppm in 4 days and below detectable limit (BDL) at 7 days in tomato when sprayed at 0.05 per cent concentration with initial residual value of 2.71 ppm. However, the initial residues of 6.04 ppm with 0.1 per cent endosulfan reached below the tolerance limit of 2 ppm after 6.8 days.

Dikshit *et al.* (1980) studied on the endosulfan was applied at concentrations of 0.05 and 0.1 per cent to tomato at the stage of fruiting and again 15 days later for the control of arthropod pests. Fruit samples were examined for residues at intervals of up to 25 days after the second application. Initial residues on the fruit were 7.35-7.85 ppm for treatment at the lower concentration and 14.40-15.20 ppm at the higher concentration. The corresponding half-lives were 2.6 and 2.1 days.

Lalitha *et al*. (1984) found that endosulfan sprayed @ 0.07 per cent and 0.10 per cent concentration, the initial deposit was 1.36 ppm and 2.04 ppm in tomato fruits whereas 1.0 ppm was recorded on brinjal fruits when sprayed with endosulfan 0.07 per cent concentration.

Kawamura *et al.* (1986) tested 109 samples of vegetables and fruits available in the market. Samples were analyzed for 43 kinds of organophosphorus pesticide residues. Residue levels in most samples were found to be 0.01 mg/kg. Frequency of pesticides was higher in fruits than vegetables.

Frank *et al*. (1987) surveyed Ontario grown vegetables in Canada for pesticide residues during 1980-85. A total of 354 samples were screened. Most of the samples contained residues well within maximum residue limits (MRLs) while the limits exceeded in only a small number of samples.

Gangwar and Kumar (1988) worked out, the detectable residues of endosulfan which persisted in tomato at medium altitude hills from 10 to 20 days when applied at 0.05, 0.10 and 0.20 per cent concentrations and with the initial average deposits of 3.36-3.88, 5.69-5.95 and 7.50-8.02 ppm corresponding to respective concentrations.

Bhattacharya *et al.* (1989) reported that endosulfan @ 500g and 1000g a.i./ha requires a safe waiting period of 6.00-10.54 days in brinjal fruits with half-life values of 2.01-2.99 days.

Raj *et al.* (1991) reported that endosulfan applied @ 0.07 per cent recorded initial deposits of 9.42 and 4.44 mg/kg on tomato and brinjal fruits, respectively. The deposits dissipated to below tolerate limit of 0.20 mg/kg for both tomato and brinjal fruits on 7 days and 1 day, respectively.

Singh *et al.* (1991) reported that the waiting period of 2 to 7 days as safer for consumption of tomato fruits during spring after endosulfan application. The residues completely wiped out within 8 to 10 days from the leaves and 6 to 8 days from the fruits.

Bhatnagar and Gupta (1993) studied on the dissipation pattern in tomato. They reported safe waiting periods of 0, 8 and 2 days, respectively for malathion, methyl dematon, and monocrotophos at their recommended doses.

Masud and Hassan (1995) surveyed during 1990-92 and collected samples of fruits and vegetables from growers fields and main selling points of North West Frontier Province, Islamabad and quetta/Pishin districts of Balochistan. Among the 300 samples analyzed, 121 samples were found to contain different pesticides in varying concentrations. Thirty-eight samples contained pesticide residues above maximum residue limits (MRL) proposed by FAO/ WHO, while the remaining samples did not contain detectable pesticide residues.

Dogheim *et al.* (1996) determined organochlorine and organophosphorus pesticide residues in food from Egyptian local markets. They conducted their work to monitor organochlorine and organophosphorus pesticide residues in potatoes, citrus fruits and fish collected from Egyptian local markets. Maximum Residue Limits (MRLs) of the Codex Committee on pesticide Residues For y-hexachlorocyclohexane (HCH) in Potatoes were exceeded in 8 samples and for DDT in 2 samples. The aging (HCH) and DDT indicated a recent use of both pesticides during the potatoes storage period between cultivation seasons. The highest residue levels of fenitrothion (3.8 ppm) in potatoes might be due to its repeated use before and after harvest. No organochlorine pesticides exceeded their MRLs.

Ahuja *et al*. (1998) monitored vegetables for pesticide residues at harvest of cauliflower, cabbage, tomatoes, brinjal, okras, cucumber, French beans and field beans were monitored for residues of HCH and its isomers, endosulfan, dimethoate, monocrotophos, quinolphos, fenvalerate, cypermethrin and the fungicides carbendazim. The residues of alpha, beta, gama isomers of HCH, endosulfan, monocrotophos, quinolphos, dimethoate and carbendazim were detected in most of the samples analyzed. However, the residues of monocrotophos on tomato, brinjal and okra and those of carbendazim were found to persist over the prescribed maximum limits.

Antonious *et al.* (1998) found that, endosulfan (Thiodan 3 EC, a mixture of alpha and beta isomers), sprayed on 92 day old field grown pepper (*Capsicum annum)* and tomato at the recommended rate of 0.61 kg a.i./ha. The initial total residues (alpha and beta endosulfan isomers plus ebdosulfan sulfate) were higher on leaves than fruits. On pepper fruits, the alpha-isomers which is the more toxic to mammals, dissipated faster than the less toxic beta-isomer. Total residues (alpha and Beta endosulfan isomers plus sulfate metabolite) on tomato leaves revealed longer persistence ($t_{½}$ - 4.6 days) compared to the total residues detected on pepper leaves($t_{½}$ - 2.0 days) 3-14 days following spraying. Persistence of beta-isomer on pepper fruits was high 3-14 days following spraying compared to on tomato fruits.

Reddy *et al.* (1998) determined pesticide residues in vegetables collected at harvest from farmer’s fields around Hyderabad, Guntur and Srikakulam districts of Andhra Pradesh in 1992-93. Brinjal, chillies and spinach samples collected around

Hyderabad, had HCH levels of 0.588, 1.513 and 0.250 ppm, respectively. These were above maximum residue limits (MRLs) of 0.25 ppm. The residues of DDT in tomatoes, brinjal, and chillies and those of cypermethrin in tomatoes were below MRL. Chillies, okra bitter gourd and cucumbers collected around Guntur had HCH levels of 0.308, 0.271, 0.367 and 0.412 ppm respectively, which were above MRL. Mancozeb levels were above MRL (2 ppm) in bitter gourd only. Vegetable sampled from Srikakulam had low levels of HCH, DDT, aldrin (including dialdrin), endosulfan and methyl parathion. These were below MRL.

Patel *et al*. (1999) observed the persistence of chloropyriphos on cabbage and brinjal fruit and they revealed that the residues persisted up to 15 days in cabbage and 10 days in brinjal. The half-life values were 1.0 and 0.3 days for cabbage when applied at 0.04 and 0.08%, respectively, while for brinjal it was 0.4 days for both application.

Marmat (2000) studied on the persistencey of polytrin C-44 EC, lindane 20 EC and endosulfan 35 EC sprayed @ 1 lit/ha, 1.2 lit/ha nad 1.5 lit/ha on okra crop at Raipur. The residues of lindane reached below maximum residue limit in okra fruits after first day of application followed by polytrin and Endosulfan and reached below maximum residue limit in okra fruits after second day of application.

Peter *et al.* (2001) evaluated the amount of chloropyrifos (1.5%) residues in tomato and aubergine (brinjal) fruits, grown in Andhra Pradesh, India in 1998. Aubergine (*cv*.Raviyya) and tomato (Indo-American hybrids) fruits were dusted twice with chloropyrifos (15 and 30 kg/ha) at a 15 day interval. Fruit samples for residue analysis were collected 0, 1, 3, 5, 7 and 15 days after second dusting. The initial deposits of chloropyrifos in tomato and aubergine fruits ranged from 0.72-1.12 micro g/g of fruit. The half-life period in aubergine fruits were 1.88 and 3.01 days at 15 and

30 kg/ha, respectively. In tomato fruits, the half-life values were 2.32 and 3.31 days at 15 and 30 kg/ha, respectively. The chloropyrifos in both fruits dissipated from 56 to 76% within 3 days after dusting. About 3-5% chloropyrifos persisted in/on tomato and aubergine fruits 14 days after dusting with 30 kg/ha.

Bhatnagar (2001) monitored 55 farmgate samples of tomato collected from nearby villages of Jaipur, two samples were found to contain phosphamidon and one sample contain endosulfan residue above MRLs values.

Singh (2001) reported cypermethrin 10EC @ 200 and 400 ml/ha applied against chilli thrips degraded faster as compared to lindane 20EC and endosulfan 35EC. Endosulfan persists up to seven days after application on chilli fruits.

Prieto *et al*. (2002) studied the dissipation of non-systemic (diazinon and malathion and systemic (methamidophos) insecticides in ripe tomato fruits. Methamidophos (900 g/ha), diazinon (879 g/ha), and malathion (855 g/ha) were applied at 1.55 lit/ha on tomato (*cv.* Rio Grande) plants grown in Zulia, Venezuela. Fruit samples were collected at 0,1,2,4,6,8,10,16,23 and 30 days after pesticides application. The residue level of methamidophos was higher and more persistent than that of diazinon and malathion, indicating that methamidophos was rapidly absorbed in tomato tissues. The percentage of residues decreased steadily throughout the study. Malathion was least persistent among the pesticides. The residue levels of diazinon and malathion were below the limit of determination (0.01 micro g/g) at the 23 day; that of methamidophos remained at 0.60 micro g/g, which is lower than the maximum residue level (2.0 micro g/g). the results suggest that the safety interval should be 1-4 days for diazinon and malathion, and more than 16 days for methamidophos.

Prem *et.al*. (2003) studied the dissipation of four insecticides like acephate (0.05%), deltamethrin (0.0028%), endosulfan (0.05%) and malathion (0.05%) on tomato (*cv*. Roma) leaves and fruit. Sample collected at 0,1,3,7 and 15 days of insecticide application. Endosulfan residues on leaves persisted for more than 15 days; those of deltamethrin and malathion persisted for 7 days. Acephate residues on fruits were not detected on the 15 day; those of deltamethrin persisted for 7 days. A half-life of 1.57 days was recorded for deltamethrin. Residues of malathion were not detected on the 7^{th} day. Waiting period of 6 days for acephate and 3 days for endosulfan were recorded for fruits. Acephate and endosulfan required a waiting period of 6 and 3 days, respectively. For deltamethrin and malathion, a waiting period was not required.

Kumari B. (2004) made exhaustive studies on pesticide residues in vegetables in Haryana. She reported dominance of residues of organophosphate insecticides as compared to other insecticide residues belonged to groups of organochlorines, synthetic pyrethroids and carbamates. In considerable cases these residues were above from their respective MRL values.

Ahmed and Hassanein (2005) conducted field trials in 2005 in Egypt to determine the dissipation rate of chloropyriphos-methyl (Reldan 50% EC) at 250 cm^3/100 lit water, profenophos (Selecron 72% EC) at 187.5 cm^3/100 lit water and methomyl (Lannate 90% SP) at 75 g/100lit water on tomato plants. The residues of these insecticides on fruits were determined by GLC and HPLC, the initial deposits of chloropyrifos-methyl, profenophos and methomyl were 2.10, 2.58 and 20.11 ppm, which decreased to 0.19, 1.41 and 0.33 ppm after 3, 1 and 13 days from spraying, respectively; such residue levels were below the maximum residue level. The estimated half-life values were 0.4898, 1.026 and 1.1867 days, respectively.

Shinde (2007) reported profenophos as least persisted insecticide for application against tomato fruit borer @ 1.0 lit/ha and 2.0 lit/ha. The half life was calculated 0.45 and 0.21 (mean value) days for profenophos insecticides when it was applied on tomato crop.

Deen *et.al*, (2008) studied on the three pesticides viz. cypermethrin, alfa-cyhalothrin and endosulfan @ 60, 15 and 300 g a.i./ha respectively were applied on okra crop and residues were determined in fruits at different time intervals. The half-life periods calculated were 3.3, 5.2 and 3.8 days and safe waiting periods 4.7, 8.6 and 8.3 days for cypermethrin, alfa-cyhalothrin and endosulfan respectively. Residue levels reached below MRL value of each pesticide in 9 days.

Dharumarajan *et al.* (2008) concluded that beta-cyfluthrin was detectable only up to 7 day and individual formulation of imidacloprid is persist up to 10^{th} day, but when both pesticides are used in mix combination it persist for 10^{th} day and 15^{th} day for beta-cyfluthrin and imidacloprid respectively.

CHAPTER 3

MATERIALS AND METHODS

The present investigation entitled **"Survey on insecticide use pattern of vegetable cultivation in Raipur district of Chhattisgarh"** was carried out during Rabi 2009-10 with the following objectives: 1). Survey on the plant protection knowledge of vegetable growers of Raipur region. 2). Seasonal abundance of vegetable insect pest at the farmer's field during Rabi season. 3). Status of insecticide residues in the farm gate sampling of vegetables. The details redarding materials used and techniques applied during the course of investigation have been described in this chapter.

3.1. Geographical Location

Raipur is situated in Central Eastern part of Chhattisgarh and lies between 20 ^{o} 16' North altitude and 81 ^{o} 36' East longitudes of 289.56 meters (MSL) above mean sea level.

3.2. Climate

Raipur falls under the tropical region of India, the climate of Raipur is dry sub humid to semi-arid with average annual rainfall of 1000-1350 mm, mostly concentrated from middle of June to September with occasional shower in winter. The maximum temperature goes as high as 48^{0}C during the summer month and minimum as low as 6^{0}C during winter months. The atmospheric humidity is high from June to October. The meteorological data were recorded at meteorological observatory, I.G.K.V. Raipur for the season.

3.3. Field survey

A survey was conducted in the vicinity of Raipur city regarding prevailing plant protection practices of vegetable growers during 2009-2010. Raipur has a suitable environment for production of a range of vegetables. The farmers try to avert the potential insect pests damage by resorting to the use of insecticides. The choice of insecticides depends mainly on the price and availability in the local market. A survey was conducted in Raipur district in areas where vegetable cultivation is well established to find out the nature and frequency of insecticides currently being used on vegetables grown in Raipur. Another purpose of the survey was to know about the awareness of farmers regarding good agricultural practices.

The field survey included collection of information through personal interview of farmers. Only those farmers were interviewed who were actively involved in vegetable cultivation. By taking of 150 vegetable growers and from these vegetable growers 30 farm gates samples collected for residue analysis. One separate questionnaire was developed for the vegetable growers as follows

Survey on the plant protection knowledge of vegetable growers of Raipur region, during Rabi season 2009-10 Conducted by the Deptt. of Entomology, College of Agriculture Raipur

Interviewer____________________ Date ____________________

1. Respondent name**:** ____________________Owner/Manager
2. Address**:**____
3. Qualification**:** Middle/ Matric/ Graduate/ Post graduate/ Illiterate
4. Fruit crops (priority areas)

Mango	Guava
Citrus	Banana
Papaya	Pomegranate

5. Vegetable crops (priority areas)

Kharif	**Winter**	**Summer**
Okra	Brinjal	Cucurbit
Tomato	Potato	Okra
Cucumber	Chili	________
Melon	Green onion	________
Pumpkin	Bitter gourd	________
Spinach	Cauliflower	
Moringa	Other	

6. Farming experience**:** (Less than 5 years/ 5-10 years/ 10-20 years**/** >20 years)

7. How are the pest managed? **(**No action/ Consult shop keepers/ Agriculture Extension/ Neighbour/ Agriculture Research/ Own/Others)

8. Pest monitoring Yes, ________ No, ________

9. If yes, how? (Tenant/ Own/ Yourself)

10. How do you confirm which pest is present by consulting (Own – your self / Neighbour / Agriculture Extension/ Agriculture Research/ Others)

11. Which insecticides you use the most for the insect pests on fruits/vegetables

12. Do you have the knowledge of ETL for pests?

13. Against which insect pest (one) you use the most of the insecticides

14. How do you apply the chemicals: own will by reading label / consult shop keepers/ Neighbour/ Agriculture Research/ Agriculture Extension?

15. Using mixtures. (Yes / No)

16. If yes, who recommend (AED/ Shop keepers/ Own/ NGO

17. Any idea about residue effect/ persistence. (Yes / No)

18. Know the interval between insecticide application and harvest

19. Who decides when to spray (Own decision/ Neighbour / Agriculture Extension/ Agriculture Research)

20. Who sprays the crop (yourself/ skilled worker)

21. Type of insecticide applicator in use (Hand operator / Power operator / Any other)

22. Use protective clothing during spray (Yes / No)

23. If no, any effect you feel: (No/ Drowsiness/ vomiting/ others)

24. Any problem what you do? (Consult doctor/ Own treatment)

25. Where to clean equipment: (Nearby stream/ in the field/ others)

26. What you do with the empty containers (Bury them/ use/ selling/ others)

27. Where to get equipment: (Own/ lending / hiring)

28. Where you place the equipment and chemicals (Separate store/ Cattle barn/ house)

29. Any knowledge about insecticide expiry: (Yes / No)

30. Attended any course on safe and effective use of insecticides (Yes / No)

31. Do you know what IPM stands for? (Yes / No)
32. What kind of IPM practices you are applying

33. Do you know any insect pest resistant varieties (Yes / No)

34. Do you apply any biological control measure (Yes / No)

    If yes describe it ____

35. Any Other problem OR suggestions?

36. Do you know about Monocotophos is banned for vegetables? (Yes / No)

On the basis of the questionnaires, farmers were interviewed and details were obtained concerning the types of insecticides used, the frequency and amounts of application, the time of insecticide application, the subsequent harvest and sale of treated crops, the contacts they make with insecticide shop keepers, researchers, extension workers for making decisions regarding the use of insecticides.

Formal interviews were conducted in the farmer's fields or homes, keeping in view the convenience of respondents. Before conducting an interview, the objective of the study was briefly explained to the respondent's highlighting the need, importance and the possible outcomes. During the process of interviewing a friendly environment was maintained so that correct and reliable information could be obtained.

The growers were asked about their farming experience, training on the safe and effective use of insecticide, awareness about residual persistence of insecticide and source of recommendations regarding time, application rate and method of application. They were asked whether they use protective clothing while they handle and spray the field. In addition, they use protective measures while they suffer from any discomfort during insecticides application.

3.4. Intensity of insect pests of vegetables in farmer's field

When visited vegetable growers field for interview the status of insect pests and natural enemies and their present populations on that crop were also recorded. The crops were observed from the vegetative to fruiting stage for insect pests and natural enemies population on randomly selected 5 plants at farmer's field.

3.4.1. Method of insect observation

(i) For Sucking Pest

Five plants of each crop were selected randomly and each plant is divided in to three regions i.e., upper, middle and lower the observation of sucking pests were taken each of three leaves, from one each (upper, middle and lower) regions.

(ii) For Fruit Borer

For recording fruit borer incidence the infested fruits were taken into account. To work out the per cent fruit infestation on randomly selected plants infested fruits were counted out of total number of fruits.

(vi) Statistical analysis of data

The data obtained on population of thrips, aphid, jassid, white fly, LBB and chrysopa were calculating mean and average populations of all locations.

Percentages of fruit damage were worked out with the help of following formula. (Abbotts, 1925)

$$\text{Percentage of fruit damage} = \frac{\text{Number of damage fruits}}{\text{Total number of fruits (Healthy + Damage)}} \times 100$$

3.5. Farm gates sampling of vegetables for insecticide residues analysis

During the field survey, fresh samples of vegetables were collected at harvest from farmers' fields to assess the residue levels of insecticides on these crops before their release into market. Laboratory Manual on Insecticide Residue Estimation published from Department of Entomology CCS Haryana Agriculture University Hisar by Kumari et al. (2004) protocols for sampling and for the portion of commodities to be analysed were followed.

Fresh samples of vegetables (2 kg) were collected from vegetable grower's field in each site. A total 30 samples were collected for 6 vegetable crops selected for monitoring. The samples were transported to laboratory immediately after collection and were extracted and stored in cool place until analysis. Analysis of insecticides for residues was mostly limited to the treatment history obtained from vegetable growers in the survey.

3.6. Methodologies employed for insecticide residues analysis

Extraction of insecticide residues from vegetables with different solvents, clean up, and their detection and quantification by different analytical techniques are the major steps involved in insecticide residue analysis.

3.6.1. Extraction of insecticide residue from vegetables

A critical review of literature showed that different solvents such as n-hexane, acetone, ethyl acetate, anhydrous sodium sulphate and sodium chloride have been used for extraction of insecticide residue from fruits and vegetables (Kumari et al. 2004). As more polar insecticides, such as organophosphates, carbamate's, organochlorines and synthetic pyrethroid's came into use, more polar solvents, such as ethyl acetate, acetone, n-hexane and anhydrous sodium sulphate were found to be good (Kumari et al. 2004).

1-2 kilogram each of the vegetable was chopped with a chopping board and mixed thoroughly. The sample was thoroughly blended to obtain a homogeneous representative sample for weighing. 20g samples was taken in a mortar and pestle and macerate it with 4-5 gm anhydrous sodium sulphate then add 100ml acetone and extracted by shaking on mechanical shaker for 1hour. After one hour extract was filtered through 2-3 cm layer of anhydrous sodium sulphate. Concentrated the extract up to 40 ml on rotary flash evaporator after adding a drop of mineral oil and diluted the extract 4-5 times with 10% NaCl aqueous solution.

Partitioned it thrice with ethyl acetate (50, 30, 30 ml) in a separatory funnel by shaking vigorously for 1 minute, combined the organic (ethyl acetate) phases and filtered through anhydrous sodium sulphate, concentrated the organic phase up to 5 ml on rotary flash evaporator and divided the concentrated extract into two equal parts (one for Organochlorines and Synthetic Pyrethroids and other for Organophosphates and Carbamate's) and then cleaned up.

3.6.2.1. Clean up of extracts for Organochlorines and Synthetic Pyrethroids.

In order to achieve the sensitivity required for analysis, the extract of insecticide residues was "cleaned up" to remove any interfering substances co-extracted with insecticide residues. For this purpose, a Florisil column adsorption chromatography technique was used (Kumari et al. 2004).

Florisil column adsorption chromatography:

Glass wool was placed at the bottom of chromatographic column fitted with draw-off valve and was used for the clean up and pack the glass column (60 cm X 22 mm i.d) with adsorbent mixture (5 gm) Florisil**:** activated charcoal (5:1 w/w) in between two layer of anhydrous sodium sulphate and tap the column gently to ensure uniform and compact packing, prewetted the column with 50 ml hexane and transfered the concentrated extract to the column and eluted the column with 125 ml solution of ethyl acetate: hexane (3:7 v/v), concentrated the elute to near dryness using rotary flash evaporator after adding one drop of mineral oil and made the final volume to 5 ml in ethyl acetate: n hexane (3:7 v/v) and then analysed using chromatographic techniques.

3.6.2.2. Clean up of extracts for Organophosphates and Carbamate's.

Glass wool was placed at the bottom chromatographic column fitted with draw-off valve and was used for the clean up and pack the glass column (60 cm X 22 mm i.d) with adsorbent mixture containing 5 gm silica gel (60-120 mesh): activated charcoal (5:1 w/w) in between 3-4 cm layers of anhydrous sodium sulphate. Ensured the compact packing of column by taping gently and prewetted the column with 50-60 ml hexane and loaded the concentrated extract to the column, eluted the column with 125 ml mixture of acetone: hexane (3:7 v/v), concentrated to near dryness using rotary flash evaporator to make the final volume to 5 ml in acetone: hexane (3:7 v/v) and then analysed using chromatographic techniques.

3.6.3. Analytical techniques used for determination insecticide residue

The chromatographic technique, i.e., Gas Chromatograph and Mass Spectrometer (GCMS QP 2010 of Schmidzon make) was used for the determination insecticide residues in vegetable samples in the present study.

3.6.3.1. Gas Chromatograph and Mass Spectrometer (GC-MS)

The multidimensional system of GC-MS is a powerful tool for the qualitative and quantitative analysis of mixtures of complex volatile insecticide compounds because of the separating abilities of GC and structure identification abilities of Mass and Com. It has been widely employed for insecticide residue monitoring studies because of its high sensitivity and specificity, as well for its potential of multiresidue and multi-class analysis.

3.6.3.2. Gas chromatograph computer programming parameters for multi-residue estimation.

Instrument : Gas Chromatograph Mass Spectrometer (GCMS-QP2010 Plus)

Column : Capillary Column (Phase – Rxi ™ – 5 ms, Length 30 m, 0.25 mm ID, 0.25 µm

(i) Parameters for GC

Column Oven Temp : 80 °C

Injection Temp : 260 °C

Injection Mode : Splitless

Sampling Time : 1.00 min

Flow Control Mode: Pressure

Temperature

Pressure : 102.7 kPa

Total Flow : 34.5 mL/min

Column Flow : 1.5 mL/min

Linear Velocity : 45.1 cm/sec

Purge Flow : 3.0 mL/min

Split Ratio : 20.0

Program: Column Oven

	Rate	Final Temperature	Hold Time
0	-	80.0	1.00
1	20.00	180.0	1.00
2	5.00	280.0	20.00
3	0.00	0.0	0.00

(ii) Parameters for MS

Ion Source Temp : 230 °C

Interface Temp : 260 °C

Solvent Cut Time : 3 min

Micro Scan Width: 0 u

Group #1- Event #1

Detector Voltage : Absolute

Detector Voltage : Absolute	0.8 kV
Threshold	1000

	Start Time (min)	End Time (min)	Acq. Mode	Event Time(sec)	Scan Speed	Start m/z	End m/z
1	3.50	25.00	Scan	0.50	1666	40.00	750.00
2	0.00	0.00	Scan	0.00	0	0.00	0.00

3.6.3.3. Gas chromatograph computer programming parameters for Malathion estimation.

(i) Parameters for GC

Column Oven Temp : 80 ^{o}C

Injection Temp : 260 ^{o}C

Injection Mode : Splitless

Sampling Time : 1.00 min

Flow Control Mode: Pressure

Temperature

Pressure : 102.7 kPa

Total Flow : 34.5 mL/min

Column Flow : 1.5 mL/min

Linear Velocity : 45.1 cm/sec

Purge Flow : 3.0 mL/min

Split Ratio : 20.0

Program: Column Oven

	Rate	Final Temperature	Hold Time
0	-	80.0	1.00
1	10.00	180.0	1.00
2	5.00	280.0	8.00
3	0.00	0.0	0.00

(ii) Parameters for MS

Ion Source Temp : 230 ^{o}C

Interface Temp : 260 ^{o}C

Solvent Cut Time : 3 min

Micro Scan Width: 0 u

Detector Voltage: Absolute

Detector Voltage: Absolute	0.8 kV
Threshold	1000

Group #1- Event #1

	Start Time (min)	End Time (min)	Acq. Mode	Event Time(sec)	Scan Speed	Start m/z	End m/z
1	3.50	35.00	Scan	0.50	1666	40.00	750.00
2	0.00	0.00	Scan	0.00	0	0.00	0.00

3.7 Interpretation of residues data

3.7.1 Residues (mg/kg)

The following formula was used to derive the residues level in test sample,

Residue Level (mg/kg) =

$$\frac{\text{Area of sample}}{\text{Area of standard}} \times \frac{\mu\text{l of sample injected}}{\mu\text{l of standard}} \times \frac{\text{final volume}}{\text{Weight of sample}}$$

CHAPTER IV

RESULTS AND DISCUSSION

The present investigation **"Survey on insecticide use pattern of vegetable cultivation in Raipur district of Chhattisgarh"** was conducted during Rabi 2009-10. Results obtained under different objectives are presented in appropriate tables and illustrated in figures along with the interpretations:-

4.1 Survey on plant protection knowledge of vegetable growers of Raipur region:

On the basis of a questionnaire developed to collect the prevailing system of plant protection among the commercial vegetable growers of different locations of Raipur, total 150 vegetable growers interviewed regarding use and application of insecticides on vegetables. During the survey, the respondents were asked about their educational status, awareness and technical know-how about insecticide use, training on the safe and effective use of insecticide, awareness about persistence of insecticide and source of recommendations regarding time, application rate and method of application. These factors play an important role in the effective use of insecticides and subsequent harvest of treated crops to avoid the insecticide hazards. The result of present survey is given under the following sub-heads:-

4.1.1 Frequently used insecticides in vegetable cultivation:

The data collected from survey reveals that most commonly using insecticides in vegetable cultivation as described by the respondent vegetable growers are given in Table 4.1. Wide range of insecticides belonging to different chemical group is used in vegetable cultivation.

Table 4.1 Commonly used insecticides of vegetables cultivation in Raipur

Insecticides	Group	Frequency of use (%)
Cypermethrin	Pyrethroid	21.09
Chloropyrifos	Organophosphate	18.81
Endosulfan	Organochlorine	13.43
Dimethoate	Organophosphate	11.47
Methomyl	Carbamates	10.23
Carbofuran	Carbamates	7.15
Imidacloprid	Neonicotyl	5.77
Trichlorofos	Organophosphate	4.81
Fenvalerate	Pyrethroid	3.85
Diazinon	Organophosphate	1.56

The most frequently used insecticides were cypermethrin (21.09%), followed by chloropyrifos (18.81%) and endosulfan (13.43%). These observations are Similar to the finding of Khan, (2005) who reported most commonly used insecticides of fruit and vegetables cultivation of cypermethrin followed by chloropyrifos and endosulfan.

It may be concluded that vegetables cultivation of Raipur district are receiving most common insecticide cypermethrin followed by chloropyrifos and endosulfan.

4.1.2 Educational status:

The respondent were classified on the basis of years of schooling and were grouped into distinct categories including those having middle, high, graduation, post graduation and having not received any formal schooling were considered as illiterate. The information gathered through the survey (Table 4.2) indicated that most of the growers i.e. 66% vegetable growers were illiterate. Only 5% of vegetable growers were graduates and post graduates, and 20% vegetable growers were found educated up to middle, while matriculates constitute percentage (8%) form total respondents of the study.

Table No.4.2 Educational status of vegetable grower in Raipur.

Sr. No.	Educational Status	Frequency (%)
1	Illiterate	66
2	Middle School	20
3	High School	8
4	Graduation	3
5	Post Graduation	2

It may be concluded that most of the vegetable growers not received any formal schooling considered illiterate (66%) followed by middle school educated (20%) and high school educated (8%).

4.1.3 Awareness about insecticide application:

Majority of farmer’s interview indicated that they did not care about the residual effects of insecticide applied on crops (Table 4.3). They spray the field in the afternoon and pick the vegetables early in the morning for selling in the market.

Table No.4.3 Awareness about insecticide application on vegetable cultivation in Raipur

Sr. No.	Particulars	Frequency (%)
1	Aware about insecticides characteristics	20
2	Unaware about insecticides characteristics	80

Table 4.3 showed that most of the vegetable growers, i.e., 80% were found unaware about the recommended doses, spraying intervals and persistence of insecticides that causes harmful effects on human health

It may be concluded that majority of vegetable growers i.e., 80% were found unaware about insecticide application particularly about their recommended doses, spraying intervals and persistence of insecticide residues in vegetables.

4.1.4 Training for insecticide handling:

During the survey vegetable growers were asked regarding attaining any training campaign for safe and effective use of insecticide (Table 4.4), it was found that only 5.7% vegetable growers had attended courses on the safe and effective use of insecticides, while remaining (94.3%) had not got any training on the safe and effective use of insecticides.

Table 4.4 Status of training for insecticide handling

Sr.No.	Particulars	Frequency (%)
1	Attended training for insecticide use	5.7
2	Not attended training for insecticide use	94.3

It may be concluded that only 5.7% vegetable growers were found trained for the safe and effective use of insecticides in the vegetable cultivation of Raipur region.

4.1.5 Consultation for identification of insect pest of vegetables:

The identification of actual insect pest problem is very important as far as the use of insecticides is concerned. In a number of cases the growers were found unable to identify and confirm the attack of particular insect species and they consult to different sources for its identification. The Table 4.5 data revealed that approximately 55.7% vegetable growers consulting insecticide shop keepers for the identification of insect attacking the crop. Only 19.9% respondents were found consulting agricultural experts of Agriculture Research Institute for this purpose, while 21.3% of vegetable growers identify the problem themselves. Remaining respondents, 17.7% were found as Laggard category and take no action for insect pest identification.

Table No.4.5 Source of Consultation for pest identification in vegetable cultivation:

Sr. No.	Consulting source for identification	Frequency (%)
1	Shop keepers	55.7
2	Agricultural experts	19.9
3	Vegetable grower themselves	21.3
4	No action for insect identification	17.7

It may be concluded that most of the vegetable growers i.e., 55.7% were consulting shop keepers to identify and confirm the pest attack followed by 21.3% respondent identify and confirm the pest attack themselves, only 19.9% vegetable growers were found consulting agricultural experts.

4.1.6 Source of recommendation of insecticides:

Different sources were found to be involved in recommending insecticides regarding time, rate and method of application to vegetable growers. Important among these were the insecticide shop keepers, agriculture experts and own experience. As seen in Table 4.6 most of the vegetable growers (81.7%) were consulting shop keepers for recommendation of insecticides while 14.1% of vegetable growers were found applying insecticides on the basis of their own experience. Only 7.8% vegetable growers were following the recommendations of agriculture experts. This finding is corroborative with the result of Kain (1998), who reported that most of the vegetable growers consult to shop keepers for insecticide recommendation.

4.6 Sources of consultation for plant protection measures in vegetable cultivation:

Sr.No.	Different source of recommendation of insecticides	Frequency (%)
1	Shop keeper	81.7
2	Vegetable grower themselves	14.1
3	Agricultural experts	7.8

It may be concluded that most of the vegetable growers of Raipur region (81.7%) were consulting shop keepers for recommendation of insecticides followed by the 14.1% those applying insecticides on their own experience and only 7.8% vegetable growers spraying the crop on the recommendation of agricultural experts.

4.1.7 Crops receiving insecticides:

The name of vegetable crops which consumes higher quantity of insecticide by frequent spraying was asked to the growers. Among the different vegetable crops following were marked for high insecticide consumption are brinjal, tomato, chilli, bean, okra and cabbage in the Raipur region. (Table 4.7)

Table 4.7 Major vegetable crops which receive insecticidal control

Sr. No.	Name of Vegetables	Sr. No.	Name of Vegetables
1	Brinjal	2	Tomato
3	Chilli	4	Bean
5	Okra	6	Cabbage

4.1.8 Insecticide applicators of vegetable cultivation:

Most of the vegetable growers, i.e., 84.4% were found spraying their crops themselves (Table 4.8), remaining 15.6% of the respondents were found unable to spray their crops, for this purpose skilled labour was hired. This finding is in agreement with the result of Khan, (2005), who also reported that 81.2% vegetable growers were found to spraying their crops themselves and 18.8% vegetable growers were found hired skilled labours for spraying insecticides on their crops.

Table 4.8 List of insecticides applicator:

Sr. No.	Particulars	Frequency (%)
1	Spraying by own	84.4
2	Spraying by others	15.6

It may be concluded that the most of the respondent growers (84.4%) were spraying insecticides themselves on their crop and only 15.6% vegetable growers take the service of hired skilled labours for spraying operation.

4.1.9 Cleaning of the spraying equipment:

During the survey vegetable growers were asked regarding cleaning of spraying equipment most respondents, (73.6%) cleaned their equipments in nearby streams/ponds and thus causing water pollution unknowiningly, while 23.7% clean the equipment in the same field. However, the remaining 2.7% were found to be negligent in this respect and they did not clean their sprayers (Table 4.9). Cleaning with sufficient soapy water is extremely important and uncleaned equipment may decrease the effectiveness of the subsequent insecticides spray. Similar finding observed by Khan (2005), who revealed that majority of vegetable growers (77.4%) clean their equipment in the streams.

Table 4.9 Cleaning sites of spraying equipment after insecticide application

Sr.No.	Cleaning sites for spraying equipment	Frequency (%)
1	Nearby stream/pond	73.6
2	In the field	23.7
3	Did not clean	2.7

It may be concluded that the majority of vegetable growers (73.6%) causing water pollution by cleaning the spraying equipment in streams/ponds nearby their farm unknowiningly.

Table 4.1.10 Disposal of empty insecticide containers:

Vegetable growers were asked regarding disposal of insecticides empty containers for safety of children's and domestic animals, majority of the vegetable growers i.e., 87.1% were found throwing the empty containers in the field, while 7.5% usually use these for domestic purpose.

Table 4.10 Mode of disposal empty containers after insecticide use

Sr. No.	Way of disposal of empty containers	Frequency (%)
1	Throwing in field	87.1
2	Use for domestic purpose	7.5
3	Buried the empty container	5.4

However, 5.4% of vegetable growers reported that they buried the empty containers (Table 4.10).

It may be concluded that most respondents (87.1%) throwing empty insecticide containers after use as such in the field because unaware about the risk of poisoning for their children's and domestic animals.

4.1.11 Use of protective clothing / impact of insecticides on health:

Respondents were asked regarding use of protective clothing like mask, gloves and apron etc. during insecticide application for the safety of applicator. Table 4.11 data revealed that only 17.2% of vegetable growers were found using protective clothing at the time of spraying and remaining 82.8% did not use any protective clothing.

Table 4.11 Status of using the protective clothing during insecticide application:

Sr. No.	Particulars	Frequency (%)
1	Vegetable growers using protective clothing	17.2 %
2	Do not use of protective clothing during spraying	82.2 %

Approximately 24% of the respondent reported that they felt giddiness and sometimes vomiting while 33% mentioned that they experienced the symptoms of diseases such as headache, sneezing, nausea, skin and eye irritations and chest discomfort after spraying the insecticides without having protective clothing.

Table 4.12 Experience of insecticide applicator for exposure while not use any protective clothing while spraying:

Sr. No.	Symptoms of diseases	Frequency (%)
1	Giddiness	24 %
2	Headache, sneezing, nausea, skin and eye irritations and chest discomfort	33 %
3	Any side effect not reported	43 %

It may be concluded that majority of the vegetable growers (82.8%) not using any protective clothing while spraying insecticides on the crop, from that 24% respondents reported that they felt giddiness and sometimes vomiting while 33% mentioned that they experienced the symptoms of diseases such as headache, sneezing, nausea, skin and eye irritations and chest discomfort after spraying the insecticides.

4.2 Seasonal abundance of vegetable insect pest at the farmers field during Rabi season:

The data collected on intensity and population fluctuation of major insect pest of vegetables at the farmers field during Rabi season 2009-10 are presented in appropriate tables and illustrated in figures mentioned under the following sub-heads.

4.2.1 Status of insect pest infestation on brinjal:

Brinjal crop grown at the different area of Raipur were surveyed for seasonal activity of insect pest and their natural enemies during different month of crop season. The intensity of insect pests was recorded in the month of December, January and February at the different locations of Raipur district.

Table: 4.13 Status of insect pest infestation on brinjal during Rabi season 2009-10

Sr. No.	Common name of insect	Scientific name	Scale	Seasonal incidence (Average of all locations)		
				December	**January**	**February**
1	Aphid	*Aphis gossypii* Glover	No./three leaves	47.2	19.25	11.6
2	Jassid	*Amrasca bigutulla bigutulla* Ishida	No./three leaves	14.25	14.33	9.5
3	Thrips	*Thrips tabaci*	No./three leaves	7.33	4.85	4.16
4	White fly	*Bemisia tabaci* Gennadius	No./three leaves	5.25	3.5	2.25
5	Fruit borer	*Leucinodes orbonalis* Guenee	Fruit infestation (%)	16.37	10.6	7.66
6	Lady bird beetle	*Coccinella septumpunctata*	No./plant	2.75	1.8	2.0
7	Chrysopa	*Chrysoperla carnea*	No./plant	1.5	1.0	1.5

The insect pest and natural enemies found associated with the crop ecosystem were aphid (*Aphis gossypii* Glover), jassid (*Amarasca bigutulla bigutulla* Ishida), thrips (*Thrips tabaci*), white fly (*Bemisia tabaci* Gennadius), and fruit borer (*Leucinodes orbonalis* Guenee) as pest. This finding is in agreement with Vishwanthrao (2002) who concluded that brinjal crop was infested by four sucking insect viz; aphid (*Aphis gossypii*), jassid (*Amarasca bigutulla bigutulla* Ishida), thrips (*Thrips tabaci*), white fly (*Bemisia tabaci* Gennadius), and fruit borer (*Leucinodes orbonalis* Guenee). Lady bird beetle (*Coccinella septumpunctata*) and chrysopa (*Chrysoperla carnea*) were observed as important predators.

Among the sap suckers aphid, jassid, thrips, and white fly infest the crop, shoot & fruit borer infest the crop as major and important internal feeder infesting the crop at vegetative and reproductive stage of plant. Lady bird beetle and chrysopa found active in the crop ecosystem as natural enemies.

The highest aphid count 47.2/three leaves was observed in the month of December afterword it declined up to 11.6/three leaves in the month of February. The higher number of jassid 14.25/three leaves and 14.33/three leaves were recorded during the month of December and January respectively then it declined up to 9.5/three leaves in the month of February. Similar finding were observed by Jain (2008), who reported the peak population of *Aphis gossypii* and *Amarasca bigutulla bigutulla* during December and January month on brinjal. While Suresh *et.al.* (1996) reported that aphid and jassid were active on brinjal (*Solanum melongena*) throughout the growing season.

The higher number of thrips was recorded in the month of December (7.33/three leaves) as compared to January and February observation. The declined trend of population were recorded for white fly in the subsequent months, the mean population observed for white fly in December month was 5.25/three leaves and mean population for February was 2.25/three leaves. The highest number of fruits infested by fruit borer (16.33%) was observed in the month of December it gradually decreasing by the subsequent pickings up to 7.66% recorded in February month. This work was corroborative with the results of Varma *et.al* (2006) who stated that the maximum population of brinjal shoots and fruit borer was observed during the month of December.

It may be concluded that aphid, jassid, white fly, thrips and fruit borer infestation were comparatively higher in the month of December.

4.2.2 Status of insect pest infestation on tomato:

Tomato crop grown at the different area of Raipur were observed for insect pests and their natural enemies during the different month of Rabi 2009-10. The seasonal activities of insect pest were recorded for the month of December, January and February at the different locations of Raipur region. The insect pests and natural enemies found associates with crop ecosystem were aphid (*Myzus persicae* Suzler), jassid (*Amarasca bigutulla bigutulla* Ishida), thrips (*Thrips tabaci*), white fly (*Bemisia tabaci* Gennadius) and fruit borer (*Helicoverpa armigera*) as pest. This finding is in agreement with Shinde (2007) who revealed that during the vegetative and reproductive period of tomato crop six different insect pests species viz; white fly (*Bemisia tabaci* Gennadius), American serpentine leaf miner (*Liriomyza trifolii* Burgess), jassid (*Amarasca bigutulla bigutulla* Ishida), thrips (*Thrips tabaci*), aphid (*Myzus persicae* Suzler) and fruit borer (*Helicoverpa armigera*) were recorded on crop. Lady bird beetle (*Coccinella septumpunctata*) and chrysopa (*Chrysoperla Carnea*) as predators found at the vegetative and reproductive stage of plant.

Table: 4.14 Status of insect pest infestation on tomato during Rabi season 2009-10

Sr. No.	Common name of insect	Scientific name	Scale	Seasonal incidence (Average of all locations)		
				December	**January**	**February**
1	Aphid	*Myzus persicae* Sulzer	No./three leaves	32.33	9.75	7.2
2	Jassid	*Amrasca bigutulla bigutulla* Ishida	No./three leaves	8.67	6.25	4.2
3	Thrips	*Thrips tabaci*	No./three leaves	3.4	3.25	2.5
4	White fly	*Bemisia tabaci* Gennadius	No./three leaves	5.8	4.75	2.75
5	Fruit borer	*Helicoverpa armigera*	Fruit infestation (%)	13.62	8.62	6.4
6	Lady bird beetle	*Coccinella septumpunctata*	No./plant	2.5	2.0	2.0
7	Chrysopa	*Chrysoperla carnea*	No./plant	1.5	1.33	1.0

The aphid count 32.33/three leaves were observed in the month of December afterword it declined up to 7.2/three leaves in February month. The higher number 8.67/three leaves of jassid count were recorded during December then it declined up to 4.2/three leaves in the month of February and highest number of thrips recorded in the month of December (3.4/three leaves) and January (3.25/three leaves) as compared to February observation. The declined trends of population were also recorded on white fly, the mean population in the month of December 5.8/three leaves and mean population for February was 2.75/three leaves. This finding is corroborative with the results of Shinde (2007) who reported December and January month for maximum population of white fly. The above finding is almost in accordance with the Men *et.al.* (1997) who reported peak abundance of white fly during the month of December and January.

The highest number of fruit infested by fruit borer (13.62%) was observed in the month of December then it gradually decreases in the subsequent pickings up to

6.4%. In case of lady bird beetle and chrysopa the highest population were recorded 2.5/plant and 1.5/plant in the month of December. Similar findings observed by Shinde (2007) who reported that lady bird beetle (*Coccinella septumpunctata*) and chrysopa (*Chrysoperla carnea*) were active during the month of December and January on tomato.

It may be concluded that aphid, jassid, white fly, thrips and fruit borer infestation were comparatively higher in the month of December followed by January and February.

4.2.3 Status of insect pest infestation on chilli crop

Chilli crop grown at the different areas of Raipur were observed for insect pests and their natural enemies during different month of crop season. The intensity of insect pests was recorded at different stages of plant in the month of December, January and February at the different locations of Raipur region. The insect pests found aphid (*Aphis gossypii* Glover), jassid (*Tricentrus bicolor* Dist.), thrips (*Scirtothrips dorsalis*), white fly (*Bemisia tabaci* Genn.) and fruit borer (*Helicoverpa armigera* Hub.) infesting chilli crop at the vegetative and reproductive stage of plant. This finding is in agreement with Singh (2001) who reported six insect species viz; aphid (*Aphis gossypii* Glover), jassid (*Tricentrus bicolor* Dist.), thrips (*Scirtothrips dorsalis*), white fly (*Bemisia tabaci* Genn.) and fruit borer (*Helicoverpa armigera* Hub.) infesting the chilli crop from seedling to fruiting stage. The population of natural enemies on the chilli crop vanished may be due to insecticidal application in the month of December, January and February.

Table: 4.15 Status of insect pest infestation on chilli during Rabi season 2009-10

Sr. No.	Common name of insect	Scientific name	Scale	Seasonal incidence (Average of all locations)		
				December	**January**	**February**
1	Aphid	*Aphis gossypii* Glover	No./three leaves	5.5	3.5	3.0
2	Jassid	*Tricentrus bicolor* Dist	No./three leaves	–	3.0	2.25
3	Thrips	*Scirtothrips dorsalis*	No./three leaves	11.5	6.83	4.83
4	White fly	*Bemisia tabaci* Gennadius	No./three leaves	2.5	2.33	2.0
5	Fruit borer	*Helicoverpa armigera*	Fruit infestation (%)	1.67	1.33	1.33

The highest aphid count 5.5/three leaves observed in the month of December afterword it declined up to 3.0/three leaves. Similar finding were observed by Singh (2001) who reported aphid population in highest number during the month of January. The higher number of jassid counts were recorded in the month of January (3.0/three leaves) then there is slight variation occurs in the month of February (2.25/three leaves). Incidence of jassid on chilli was not observed during the month of December it may be due to non occurance of this pest. The highest number of thrips recorded in the month of December (11.5/three leaves), then it declined up to 6.83/three leaves and 4.83/three leaves during the month of January and February respectively. This work was corroborative with the results of Singh (2001) who reported the peak population of thrips on chilli (15.87/tree leaves) in the month of December. The declining trend in population were recorded for white fly in the month of December which is 2.5/three leaves and mean population for February was 2.0/three leaves and higher fruit infestation 1.67% was observed in the month of December. It decreases in the subsequent picking up to 1.33%.

It may be concluded that aphid, jassid, thrips and fruit borer infestation were comparatively higher in the month of December.

4.2.4 Status of insect pest infestation on okra crop:

Okra crop grown at the different area of Raipur were surveyed for insect pests and their natural enemies during the different month of crop season. The intensity of the insect pests was recorded at different stages of plant in the month of December, January and February at the different area of Raipur region.

The insect pests and natural enemies found associated with the crop ecosystem were aphid (*Aphis gossypii* Glover), jassid (*Amarasca bigutulla bigutulla* Ishida), thrips (*Thrips tabaci*), white fly (*Bemisia tabaci* Genn.) and shoot & fruit borer (*Erias insulana* Boisduval) as pest. Incidence of natural enemies on okra crop vanished may be due to insecticidal application. The insect pest incidences observed at the vegetative and reproductive stage of plant.

Among the sap suckers i.e., aphid, jassid, thrips, white fly infest the okra crop and fruit borer infested the crop as major and important internal feeder. Severity of these insect were recorded during December, January and February month of Rabi season 2009-10.

Table: 4.16 Status of insect pest infestation on okra during Rabi season 2009-10

Sr. No.	Common name of insect	Scientific name	Scale	Seasonal incidence (Average of all locations)		
				December	January	February
1	Aphid	*Aphis gossypii* Glover	No./three leaves	5.4	3.83	3.25
2	Jassid	*Amrasca bigutulla bigutulla* Ishida	No./three leaves	3.25	2.75	2.33
3	Thrips	*Scirtothrips dorsalis*	No./three leaves	2.75	1.66	1.5
4	White fly	*Bemisia tabaci* Gennadius	No./three leaves	5.16	2.5	2.0
5	Fruit borer	*Earias insulana* Boisduval	Fruit infestation (%)	10.87	8.14	5.8

The highest aphid count 5.4/three leaves were observed in the month of December afterword it declined up to 3.25/three leaves in February. The higher number 3.25/three leaves jassid counts were recorded during December then it declined up to 2.33/three leaves in the February month. The higher number of thrips was recorded in the month of December 2.75/three leaves as compared to January and February. The declined trend of population were also observed for white fly the highest mean population was recorded 5.16/three leaves in the month of December and mean population in February month was 2.0/three leaves. The highest infested okra fruits 10.87% were recorded in December it gradually decreased because of the subsequent picking up to 5.8% was recorded in the month of February.

It may be concluded that aphid, jassid, white fly, thrips and fruit borer infestation in okra crop was comparatively higher during the month of December.

4.2.5 Status of insect pest infestation on cabbage:

Cabbage crop grown at the different areas of Raipur were observed for the insect pests and their natural enemies at the different month of crop season. The intensity of insect pest were recorded at the different stages of plant in the month of December, January and February of Rabi season 2009-10 for different locations of Raipur region. The insect pests were found associated with the cabbage crop ecosystem were aphid (*Lipaphis erysimi* Kalt.), white fly (*Bemisia tabaci* Genn.) and diamond back moth (*Plutella xylostella* Linn.) as pest. The incidence of natural enemies on cabbage crop vanished at the time of observation may be due to insecticidal application. The incidence of these insect pests was observed at different stages of plant.

Among the sap suckers aphid and white fly found to infest the crop and DBM infested the crop as one of the major and important foliage feeder. Severities of these insect pests were observed during the month of December, January and February of Rabi season 2009-10.

The highest aphid counts 3.2/three leaves and 3.25/three leaves was observed during the month of December and January respectively, afterword there is slight variation in population observed during February (2.5/three leaves). This finding is corroborative with the results of Sahu (2008) who reported aphid occurrence on cabbage during the month of January.

Table: 4.17 Status of insect pest infestation on cabbage during Rabi season 2009-10

Sr. No.	Common name of insect	Scientific name	Scale	Seasonal incidence (Average of all locations)		
				December	January	February
1	Aphid	*Lipaphis erysimi* Kaltenbach	No./three leaves	3.2	3.25	2.5
2	White fly	*Bemisia tabaci* Gennadius	No./three leaves	3.6	3.33	2.0
3	Diamond back moth	*Plutella xylostella* Linnaeus	Larvae/plant	7.25	6.5	3.33

The higher number 3.6/three leaves and 3.33/three leaves of white fly count were recorded during the month of December and January respectively then it declined up to 2.0/three leaves in the month of February. The highest number of DBM larvae 7.25/plant were recorded in the month of December it gradually decrease in February up to 3.3 larvae/plant. Similar finding were also observed by the Sahu (2008) who reported peak population diamond back moth during the month of December.

It may be concluded that aphid and white population were comparatively higher in the month of December. The peak population of DBM larvae was recorded during the month of December and January.

4.2.6 Status of insect pest infestation on cucurbit crop:

Cucurbit crops grown at the different area of Raipur were surveyed for insect pests and their natural enemies during different month of crop season. The intensity of insect pests was recorded at the different stages of plant in the month of December, January and February from different part of Raipur region. The insect pests and natural enemies associated with the crop ecosystem were aphid (*Myzus persicae* Sulzer**),** jassid (Amarasca bigutulla bigutulla Ishida), thrips (*Scirtothrips dorsalis*), white fly (Bemisia tabaci Genn.) and red pumpkin beetle (*Aulacophora foveicolis* Lucas) as pest and lady bird beetle (*Coccinella septumpunctata*) and chrysopa (*Chrysoperla carnea*) as predators. The incidence of these insect pests was observed at the vegetative and reproductive stage of plant.

Among the sap suckers aphid, jassid, thrips and white fly found to infest the crop and red pumpkin beetle infesting the crop as one of the important foliage feeder and lady bird beetle and chrysopa were observed as natural enemies in the crop ecosystem. Severity of these insect pests was observed during December, January and February month of the Rabi season 2009-10.

The higher number 12.67/three leaves jassid count were recorded during the month of December then it declined up to 6.67/three leaves in the month of February. The higher number of thrips recorded in December 7.0/three leaves as compared to January and February. The declining trend of white fly population were recorded, the mean population recorded in the month of December and January was 6.75/three leaves and 6.7/three leaves respectively and mean population during February was 3.67/three leaves. The highest number of red pumpkin beetle 9.67/plant was observed in the month of December afterword it declined up to 4.33/plant.

Table: 4.18 Status of insect pest infestation on cucurbits during Rabi season 2009-10

Sr. No.	Common name of insect	Scientific name	Scale	Seasonal incidence		
				December	**January**	**February**
1	Aphid	*Myzus persicae* Sulzer	No./three leaves	20.5	16.25	8.75
2	Jassid	*Amrasca bigutulla bigutulla* Ishida	No./three leaves	12.67	9.33	6.67
3	Thrips	*Scirtothrips dorsalis*	No./three leaves	7.0	6.25	4.0
4	White fly	*Bemisia tabaci* Gennadius	No./three leaves	6.75	6.7	3.67
5	Red pumpkin beetle	*Aulacophora foveicollis* Lucas	No./plant	9.67	8.25	4.33
6	Lady bird beetle	*Coccinella septumpunctata*	No./plant	4.33	2.75	2.33
7	Chrysopa	*Chrysoperla carnea*	No./plant	3.0	2.25	1.0

In case of lady bird beetle and chrysopa the initial population were recorded 4.33/plant and 3.0/plant respectively during the month of December. The slight variation observed in the periodical observation recorded during the month of January and February.

It may be concluded that aphid, jassid, thrips, white fly red pumpkin beetle population were comparatively higher in the month of December.

4.3 Status of insecticide residues in the farm gate sampling of vegetables

A farm gate survey was conducted in the vicinity of Raipur for monitoring of insecticide residues in vegetables at the time of harvesting. While surveying freshly harvested samples of vegetables were collected to assess the critical residue levels of organochlorine, organophosphate, carbamate and synthetic pyrethroids group insecticides in the crops. The samples were extracted, cleaned- up and analyzed by using Gas Chromatograph and Mass Spectrometer (GCMS). The maximum residue limit (MRL) and safe waiting period for the different insecticides decided by AICRP on insecticide residue for different vegetables were considered for making conclusions.

Insecticide residue level was detected from the freshly collected samples of six vegetables from different locations have been presented in Table 4.3.1-4.3.6. Total 30 samples of major vegetables analyzed for detection of insecticides residue are presented in the appropriate tables.

4.3.1 Detection of insecticide residues in brinjal fruits:

Total five samples of brinjal were collected from different five locations of Raipur district during 13/12/2009 to 14/02/2010 of Rabi season 2009-10. All the farm gate samples analyzed for detection of insecticide residues. Out of which 80% brinjal samples were found contaminated with the following three insecticides viz; endosulfan, chloropyrifos and malathion and remaining 20% samples were found free from the insecticide residues.

The endosulfan insecticide was used more frequently by the vegetable growers followed by chloropyrifos on brinjal. The residue level detected was highest for malathion followed by endosulfan and chloropyrifos. The residue was not detected from the sample of Pirda site. The permissible level of insecticide residues for malathion is 3.0 mg/kg, endosulfan is 2.0 mg/kg and chloropyrifos is 0.2 mg/kg. it was found that brinjal sample collected from Nadanvan site contained high level of residues of malathion 4.67 mg/kg followed by Aarang site where the residues of endosulfan were observed 2.36 mg/kg and in Doma site the residues of chloropyrifos was detected 1.58 mg/kg which is above the MRL value. The safe waiting period for malathion, endosulfan and chloropyrifos were worked out for 4, 5 and 7 days respectively by AICRP on insecticide residue. Vegetable grower of Nadanvan, Aarang and Doma sites had not followed the safe waiting period at the time of picking, therefore the residues of malathion, endosulfan and chloropyrifos were detected above MRL value.

It may be concluded that brinjal crop harvested within 2, 3 and 3 days of spraying had shown the residues of malathion, endosulfan and chloropyrifos respectively above the MRL value.

4.3.2 Detection of insecticide residues in tomato fruits:

Total five samples of tomato were collected from different four locations of Raipur district during 02/01/2010 to 14/02/2010 of Rabi season 2009-10. All the farm gate samples were analysed for detection of insecticide residues. Out of which 60% tomato samples were found contaminated with the following two insecticides viz; chloropyrifos and endosulfan and remaining 40% samples were found free from the insecticide residues.

The endosulfan insecticide was used more frequently by the vegetable growers followed by chloropyrifos on tomato. The residue level detected was highest for endosulfan followed by chloropyrifos. Insecticide residues were not detected on the sample collected from Dateranga and Bhatagaon site. The permissible level of insecticide residues for endosulfan is 2.0 mg/kg and chloropyrifos is 0.2 mg/kg. The tomato sample collected from Kumahari site contained highest level of endosulfan residues 3.25 mg/kg followed by Bhatagaon site where the residues of chloropyrifos was observed 0.87 mg/kg which had shown the residue level above the MRL value. The safe waiting period for endosulfan and chloropyrifos were worked out for 7 and 8 days respectively by AICRP on insecticide residue. The vegetable growers of Kumahari and Bhatagaon sites had not followed the safe waiting period at the time of picking, therefore the residues of endosulfan and chloropyrifos were detected above the MRL value.

It may be concluded that the tomato crop harvested within 2 and 4 days of spraying had shown the residues of endosulfan and chloropyrifos respectively above the MRL value.

4.3.3 Detection of insecticide residues in bean crop:

Total five samples of bean were collected from different four locations of Raipur district during 02/01/2010 to 17/02/2010 of Rabi season 2009-10. All the farm gate samples were analyzed for detection of insecticide residues. Out of which 20% bean samples were found contaminated with the endosulfan and remaining 80% samples were free from the insecticide residues.

The endosulfan insecticide was used more frequently by vegetable growers on the bean. The residue level was not detected on the sample collected from Mujgahan, Kumahari and Nadanvan site. The permissible level of insecticide residues for endosulfan is 2.0 mg/kg. Bean sample collected from Chandandih site contained highest level of endosulfan residues 2.11 mg/kg which was above the MRL. The safe waiting period for endosulfan is worked out for 11 days by AICRP on insecticide residue. The vegetable growers of Chandandih site had not followed the safe waiting period at the time of picking; therefore the residues of endosulfan were detected above the MRL value.

It may be concluded that bean crop harvested within 4 days of spraying had shown the residue level of endosulfan above the MRL value.

4.3.4 Detection of insecticide residues in chilli crop:

Total five samples of chilli were collected from different five locations of Raipur district during 02/01/2010 to 25/02/2010 of Rabi season 2009-10. All the farm gate samples were analyzed for detection of insecticide residues. Out of which 40%

chilli samples were found contaminated with the cypermethrin insecticide and remaining 60% samples were found free from the insecticide residues.

The cypermethrin insecticide was used more frequently by the vegetable growers on the chilli. The residue level was not detected on the samples collected from Mujgahan, Bhatagaon and Kumahari site. The permissible level of insecticide residues for cypermethrin is 0.5 mg/kg. Chilli crop sample collected from Nadanvan site contained highest level of cypermethrin residues 0.83 mg/kg followed by Chandandih site where the residues of cypermethrin was observed 0.67 mg/kg which is above the MRL. The safe waiting period for cypermethrin is worked out 3 days by AICRP on insecticide residue. The vegetable growers of Nadanvan and Chandandih sites had not followed the safe waiting period at the time of picking; therefore the residues of cypermethrin was detected above the MRL value.

It may be concluded that chilli crop harvested within 3 and 4 days of spraying had shown the residues of cypermethrin above the MRL.

4.3.5 Detection of insecticide residues in okra crop:

Total five samples of okra were collected from different five locations of Raipur district during 11/12/2009 to 25/02/2010 of Rabi season 2009-10. All the farm gate samples were analysed for the detection of insecticide residues. Out of which 40% okra samples were found contaminated with the following two insecticides viz; chloropyrifos and endosulfan and remaining 60% samples were found free from the insecticide residues.

The chloropyrifos insecticide was used more frequently by the vegetable growers followed by endosulfan on the okra crop. The residue level detected was highest for chloropyrifos followed by endosulfan. The residue was not detected on the samples collected from Aarang, Pirda and Bhatagaon site. The permissible level of insecticide residues for chloropyrifos is 0.2 mg/kg and endosulfan is 2.0 mg/kg. It was found that the okra sample collected from Mujgahan site contained highest level of chloropyrifos residues 1.37 mg/kg which had shown the residue level above the MRL and sample collected from Nadanvan site detected the residues of endosulfan 0.83 mg/kg which is below MRL. The safe waiting period for chloropyrifos and endosulfan were worked out for 5 and 4 days respectively by AICRP on insecticide residue. The vegetable growers of Mujgahan site had not followed the safe waiting period at the time of picking; therefore the residue of chloropyrifos was detected above the MRL value.

It may be concluded that the okra crop harvested within 2 days of spraying had shown the residue level of chloropyrifos above the MRL value.

4.3.6 Detection of insecticide residues in cabbage crop:

Total five samples of cabbage were collected from different three locations of Raipur district during 17/12/2009 to 14/02/2010 of Rabi season 2009-10. All the farm gate samples analyzed for the detection of insecticide residues. Out of which 40% cabbage samples were found contaminated with the following two insecticides viz; chloropyrifos and endosulfan and remaining 60% samples were found free from the insecticide residues.

The chloropyrifos insecticide was used more frequently by the vegetable growers followed by endosulfan on the cabbage. The residue level detected was highest for endosulfan followed by chloropyrifos. The residue was not detected on the samples collected from Aarang, Kumahari and Nadanvan site. The permissible level of insecticide residues for endosulfan is 2.0 mg/kg and for chloropyrifos is 0.2 mg/kg. Cabbage sample collected from Nadanvan site contained highest level of endosulfan residues 2.51 mg/kg followed by Aarang site where the residues of chloropyrifos were observed 0.43 mg/kg which is above the MRL. The safe waiting period for endosulfan and chloropyrifos were worked out for 8 and 10 days respectively by AICRP on insecticide residue. The vegetable growers of Nadanvan and Aarang sites had not followed the safe waiting period at the time of harvesting; therefore the residue of endosulfan and chloropyrifos were detected above the MRL value.

It may be concluded that cabbage crop harvested within 3 and 4 days of spraying had shown the residue of endosulfan and chloropyrifos respectively above the MRL value.

Total 30 representative samples of six vegetables collected from different locations of Raipur region analyzed for detection of insecticide residue based on previous history of application. The insecticide residue was not detected on 53% samples, however 37% samples were found contaminated with insecticide residue above the MRL value and residue level was detected below MRL for 10% samples analyzed under this study.

CHAPTER-V

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH WORK

The present investigation entitled **"Survey on insecticide use pattern of vegetable cultivation in Raipur district of Chhattisgarh"** was conducted during 2009-10. The objectives of this study are: - 1) Survey on the plant protection knowledge of vegetable growers of Raipur region, 2) Seasonal abundance of vegetable insect pest at the farmer's field during Rabi season and 3) Status of insecticide residues in the farm gate sampling of vegetables. The survey was conducted at the 40 kilometer periphery of Raipur city, while intensity of insect pest of vegetables were recorded at the farmers field and farm gate samples collected were analyzed for insecticide residues in the Toxicology laboratory, Department of Entomology, College of Agriculture (I.G.K.V.) Raipur. The significant findings of different objectives are summarized here:-

5.1 Summary:-

5.1.1 Survey on the plant protection knowledge of vegetable growers of Raipur region:-

Ten insecticides belonging to different groups were found to use on vegetable by respondent farmers. The most frequently used insecticide was cypermethrin followed by chloropyrifos and endosulfan in vegetable pest management. The information gathered through the survey regarding education status of grower indicated that most of the growers i.e. 66% were illiterate only 5% vegetable growers were graduates and post graduates and 20% vegetable growers have education up to middle, while matriculates constitute only 8%. The awareness was not found in 80% vegetable growers about recommended doses, spraying intervals and persistence of insecticide residues in vegetables. About 5.7% vegetable growers found as trained for the safe and effective use of insecticide. Among the respondents 55.7% vegetable growers were found to consult shop keepers for pest problem identification followed by 21.3% respondent identify the pest problem themselves, only 19.9% vegetable growers were found consulting agricultural experts. About 81.7% respondents were consulting shop keepers for recommendation of insecticide followed by the 14.1% who applying insecticides on their own experience and only 7.8% vegetable growers spraying the crop on the recommendations of agricultural experts.

The chemical controls are mostly being applied on brinjal, tomato, chilli, bean, okra and cabbage crops. Most of the respondents 84.4% were spraying insecticides themselves on their crop and only 15.6% vegetable growers take the service of hired skilled labours for spraying operation. Majority of the vegetable growers 73.6% are causing water pollution by cleaning the spraying equipment in the streams/pond nearby their farm. About 87.1% respondents throw their empty insecticides containers after use as such in field because of unawareness about the risk of poisoning for their kids and pets. Majority of the vegetable growers 82.8% not using any protective clothing while spraying insecticide on crop, out of that 24% respondents reported giddiness and some times vomiting while 33% mentioned the symptoms of diseases such as headache, sneezing, nausea, skin and eye irritations and chest discomfort after spraying insecticides.

5.1.2 Seasonal abundance of vegetable insect pest at the farmer's field during Rabi season:-

Intensity of insect pest and predators of brinjal crop were recorded during different month of crop season. The highest aphid count 47.2/three leaves was observed during month of December afterword it declined up to 11.6/three leaves in the month of February. The higher number jassids 14.25/three leaves and 14.33/three leaves were recorded during month of December and January respectively then it declined up to 9.5/three leaves in the month of February. The higher number of thrips was recorded in the month of December (7.33/three leaves) as compared to January and February observation. The declined trend of population was also recorded for white fly, in the subsequent months, the mean population of white fly in December month was 5.25/three leaves and mean population for February was 2.25/three leaves. The highest number of infested fruits by fruit borer (16.33%) was observed in the month of December it gradually decreases in subsequent pickings up to 7.66% in the month February. In case of lady bird beetle and chrysopa the highest population were recorded 2.75/plant and 1.5/plant in the month of December.

The intensity of insect pest and predators of tomato crop were recorded during different month of crop season. The highest aphid count 32.33/three leaves were observed in the month of December afterword it declined up to 7.2/three leaves in the month February. The higher number 8.67/three leaves jassid counts were recorded during December then it declined up to 4.2/three leaves in the month of February. Highest thrips counts were recorded in the month of December (3.4/three leaves) and January (3.25/three leaves) as compared to February observation. The declined trends of population were recorded for white fly, the mean population in the month of December was recorded 5.8/three leaves and mean population for February was 2.75/three leaves. The highest number of fruit infested by fruit borer (13.62%) was observed in the month of December it gradually decreases in the subsequent pickings up to 6.4%. In case of lady bird beetle and chrysopa the highest population were recorded 2.5/plant and 1.5/plant respectively in the month of December.

Intensity of insect pest and predators of chilli crop were recorded during the different month of crop season. The natural enemy (predators) on the chilli crop was not observed may due to insecticidal application in the respective month. The highest aphid count 5.5/three leaves were observed in the month of December afterword it declined up to 3.0/three leaves. The higher number jassid counts recorded 3.0/three leaves in the month of January then there is slight variation occurs in the month of February (2.25/three leaves). Incidence of jassid on chilli not observed during the month of December it may be due to non occurrence this pest this year. The highest thrips count 11.5/three leaves was recorded in the month of December, then it declined up to 6.83/three leaves and 4.83/three leaves during the month of January and February respectively. The declining trend in population was also recorded for white fly in the month of December which is 2.5/three leaves in the month of December and mean population for February was recorded 2.0/three leaves. The higher numbers of infested fruits 1.67% were observed in the month of December. It decreases in the subsequent picking up to 1.33% in February.

Intensity of insect pest and predators of okra crop were recorded during the different month of crop season. Activity of natural enemies (predators) on okra crop was not observed may be due to insecticidal application during the respective month. The highest aphid count 5.4/three leaves was observed in the month of December afterword it declined up to 3.25/three leaves in the month of February. The higher number 3.25/three leaves jassid counts were recorded during December then it declined up to 2.33/three leaves in the February. The higher number of thrips was recorded in the month of December 2.75/three leaves as compared to January and February. The declining trend in population were observed for white fly, the highest mean population was recorded 5.16/three leaves in the month of December and mean population in February was 2.0/three leaves. The highest number of infested okra fruits 10.87% were recorded in December it gradually decrease in the subsequent picking up to 5.8% in the month of February.

Intensity of insect pest and predators of cabbage crop were recorded during the different month of crop season. The activity of natural enemies on cabbage crop was not observed at that time may be due to insecticidal application in the respective month. The highest aphid counts 3.2/three leaves and 3.25/three leaves was observed during the month of December and January, afterword there is slight variation in population during the month of February (2.5/three leaves). The higher number 3.6/three leaves and 3.33/three leaves white fly count were recorded during the month of December and January respectively then it declined up to 2.0/three leaves in the month of February. The highest number of DBM larvae 7.25/plant were recorded in the month of December it gradually decrease in February up to 3.3 larvae/plant.

Intensity of insect pest and predators of cucurbit were recorded during the different month of crop season. The highest aphid count 20.5/three leaves was observed in the month of December afterword it declined up to 8.75/three leaves in the month of February. The higher number 12.67/three leaves jassid count were recorded during the month of December then it declined up to 6.67/three leaves in the month of February. The higher number of thrips was recorded in December 7.0/three leaves as compared to January and February. The declining trend in population were recorded for white fly, the mean population recorded in the month of December and January was 6.75/three leaves and 6.7/three leaves respectively and 3.67/three leaves during the month of February. The highest number of red pumpkin beetle 9.67/plant was observed in the month of December afterword it declined up to 4.33/plant. In case of lady bird beetle and chrysopa the initial population were recorded 4.33/plant and

3.0/plant during the month of December. There is slight decrease in population was observed in the periodical observation recorded during the month of January and February.

5.1.3 Status of insecticide residues in the farm gate sampling of vegetables:-

Total five representative samples of brinjal were collected from different five locations of Raipur district. All the samples were analyzed for detection of insecticide residues, out of which 80% brinjal samples were found contaminated with the following three insecticides viz; endosulfan, chloropyrifos and malathion. The remaining 20% samples were found free from insecticide residues. It was found that brinjal sample collected from Nadanvan site contained highest level of residues of malathion 4.67 mg/kg followed by Aarang site where the residues of endosulfan was observed 2.36 mg/kg and in Doma site the residues of chloropyrifos was detected 1.58 mg/kg which is above the MRL value.

Total five representative samples of tomato were collected from different four locations of Raipur district. All the samples were analyzed for detection of insecticide residues, out of which 60% tomato samples were found contaminated with the following two insecticides viz; chloropyrifos and endosulfan. The remaining 40% samples were found free from insecticide residues. The sample collected from Kumahari site contained highest level of endosulfan residues 3.25 mg/kg followed by Bhatagaon site where the residues of chloropyrifos was observed 0.87 mg/kg which is above the MRL value.

Total five representative samples of bean were collected from different four locations of Raipur district. All the samples were analyzed for detection of insecticide residues, out of which 20% bean samples were found contaminated with the endosulfan and remaining 80% samples were found free from insecticide residues.

The sample collected from Chandandih site contained highest level of endosulfan residues 2.11 mg/kg which is above the MRL value.

Total five representative samples of chilli were collected from different five locations of Raipur district. All the samples analyzed for detection of insecticide residues, out of which 40% chilli sample found contaminated with the cypermethrin and remaining 60% samples were found free from insecticide residues. The sample collected from Nadanvan site contained highest level of cypermethrin residues 0.83 mg/kg followed by Chandandih site where the residues of cypermethrin was observed 0.67 mg/kg which is above the MRL value.

Total five representative samples of okra were collected from different five locations of Raipur district. All the samples were analyzed for detection of insecticide residues out of which 40% okra samples were found contaminated with the following two insecticides viz; chloropyrifos and endosulfan, remaining 60% samples were found free from insecticide residues. The sample collected from Mujgahan site contained highest level of chloropyrifos residues 1.37 mg/kg which had shown the residue level above MRL and sample collected from Nadanvan site detected residues of endosulfan 0.83 mg/kg which is below MRL value.

Total five representative samples of cabbage were collected from different three locations of Raipur district. All the samples were analyzed for detection of insecticide residues out of which 40% cabbage samples were found contaminated with the following two insecticides viz; chloropyrifos and endosulfan, remaining 60% samples were found free from insecticide residues. The sample collected from Nadanvan site contained highest level of endosulfan residues 2.51 mg/kg followed by Aarang site where the residues of chloropyrifos was observed 0.43 mg/kg which is above the MRL value.

5.2 Conclusion

Following conclusions may be drawn under the investigation entitled **"Survey on insecticide use pattern of vegetable cultivation in Raipur district of Chhattisgarh"** conducted during Rabi 2009-10.

5.2.1 Survey on the plant protection knowledge of vegetable growers of Raipur region:-

1. Cypermethrin 21.09% followed by chloropyrifos 18.81% and endosulfan 13.43% were most frequently used insecticides in Raipur region.
2. Most of the vegetable growers 66% had not received any formal schooling considered illiterate (followed by 20% middle educated and 8% metric educated.
3. About 80% vegetable growers were found unaware about insecticide application technique.
4. For safe and effective use of insecticides in vegetable cultivation only 5.7% vegetable growers were found trained.
5. Majority of vegetable growers 55.7% were consulting shop keepers for identification and confirmation of pest attack followed by 21.3% respondents identify and confirm the pest attack themselves and only 19.9% vegetable growers were found consulting agricultural experts.
6. About 81.7% vegetable growers were consulting shop keepers for recommendation of insecticides followed by the 14.1% applying insecticides on their own experience and only 7.8% vegetable growers spraying the crop on the recommendations of agricultural experts.
7. Brinjal, tomato, chilli, bean, okra and cabbage were marked for high insecticide consumption in the Raipur region.

8. Most of the vegetable growers 84.4% were spraying insecticides themselves on their crop and only 15.6% vegetable growers take the service of hired skilled labours for spraying operation.
9. About 73.6% vegetable growers clean the spraying equipment in stream/pond nearby their farm and causing water pollution unknowiningly.
10. Vegetable growers (87.1%) throwing empty containers of insecticide after use as such in field because unaware about the risk of poisoning for their child and pets
11. Majority of the vegetable growers (82.8%) not using any protective clothing while spraying the insecticides on crop from that 24% respondent reported they felt giddiness and vomiting while 33% mentioned they experienced diseases such as headache, sneezing, nausea, skin and eye irritations and chest discomfort.

5.2.2 Seasonal abundance of vegetable insect pest at the farmer's field during Rabi season:-

1. The higher population of aphid (*Aphis gossypii*), jassid (*Amarasca bigutulla bigutulla* Ishida), thrips (*Thrips tabaci*), white fly (*Bemisia tabaci* Gennadius), and fruit borer (*Leucinodes orbonalis* Guenee) as pest and Lady bird beetle (*Coccinella septumpunctata*) and chrysopa (*Chrysoperla carnea*) predators of brinjal crop ecosystem was observed in the month of December.
2. The higher population of aphid (*Myzus persicae* Suzler), jassid (*Amarasca bigutulla bigutulla* Ishida), thrips (*Thrips tabaci*), white fly (*Bemisia tabaci* Gennadius) and fruit borer (*Helicoverpa armigera*) as pest and Lady bird beetle (*Coccinella septumpunctata*) and chrysopa (*Chrysoperla Carnea*) predators of tomato crop ecosystem was observed in the month of December.

3. The higher population aphid (*Aphis gossypii* Glover), jassid (*Tricentrus bicolor* Dist.), thrips (*Scirtothrips dorsalis*), white fly (*Bemisia tabaci* Genn.) and fruit borer (*Helicoverpa armigera* Hub.) as pest of chilli crop ecosystem was observed in the month of December.
4. The higher population of aphid (*Aphis gossypii* Glover), jassid (*Amarasca bigutulla bigutulla* Ishida), thrips (*Thrips tabaci*), white fly (*Bemisia tabaci* Genn.) and shoot & fruit borer (*Erias insulana* Boisduval) as pest of okra crop ecosystem was observed in the month of December.
5. The higher population of aphid (*Lipaphis erysimi* Kalt.), white fly (*Bemisia tabaci* Genn.) and diamond back moth (*Plutella xylostella* Linn.) as pest of cabbage crop ecosystem was observed in the month of December.
6. The higher population of aphid (*Myzus persicae* Sulzer**),** jassid (Amarasca bigutulla bigutulla Ishida), thrips (*Scirtothrips dorsalis*), white fly (Bemisia tabaci Genn.) and red pumpkin beetle (*Aulacophora foveicolis* Lucas) as pest and Lady bird beetle (*Coccinella septumpunctata*) and chrysopa (*Chrysoperla Carnea*) predators of cucurbite crop ecosystem was observed in the month of December.

5.2.3 Status of insecticide residues in the farm gate sampling of vegetables:-

1. About 80% brinjal samples were found contaminated with the chloropyrifos, endosulfan and malathion insecticide. Brinjal crop harvested within 2, 3 and 3 days of spraying had exceeded the MRL value of malathion, endosufan and chloropyifos respectively.
2. 60% tomato samples were found contaminated with the chloropyrifos and endosulfan insecticide. Tomato crop harvested within 2 and 4 days of spraying had exceeded the MRL value of endosufan and chloropyifos respectively.

3. Only 20% bean samples were found contaminated with the endosulfan insecticide. Bean crop harvested within 4 days of spraying had exceeded the MRL value of endosufan.
4. About 40% chilli samples were found contaminated with the cypermethrin insecticide. Chilli crop harvested within 3 and 4 days of spraying had exceeded the MRL value of cypermethrin.
5. 40% okra samples were found contaminated with the chloropyrifos and endosulfan insecticide. Okra crop harvested within 2 days of spraying had exceeded the MRL value of chloropyifos.
6. About 40% cabbage samples were found contaminated with the chloropyrifos and endosulfan insecticide. Cabbage crop harvested within 3 and 4 days of spraying had exceeded the MRL value of endosufan and chloropyifos respectively.

5.3 Suggestions for future research work

- This work may be extended for larger area of vegetable/fruit cultivation in different seasons.
- Insecticide residue monitoring studies may be conducting for other food crops and processed/preserved food.
- Dissipation pattern studies may be conducted under different environmental conditions for various insecticides.
- Genetic resources of plant may also be explored to develop the suitable variety of crops for fast decomposition of insecticide residues.
- Non chemical approaches for vegetable pest management may be developed for vegetable and fruit.

Survey on Insecticide Use Pattern of Vegetable Growers in Raipur District Of Chhattisgarh

By

KATEKAR HARISH PAVAN

ABSTRACT

The extensive and indiscriminate use of insecticides on vegetables posses serious residue problems hazards for human health, natural enemies and environment. A monitoring study entitled **"Survey on insecticide use pattern of vegetable cultivation in Raipur district of Chahttisgarh"** was conducted at the 40 km periphery of Raipur city during Rabi 2009-10.

Prevailing plant protection practices in respect to good agricultural practices, intensity of insect pest and their natural enemies during different month of crop season and insecticide residue level in farm gate samples for major vegetable crops were investigated. It was found that cypermethrin¸chlorpyriphos and endosulfan were the most frequently used insecticide on brinjal, tomato, chilli, bean, okra and cabbage crop. Most of the vegetable growers were found unaware about the safe and effective use of insecticide, safe disposal of empty containers and cleaning sprayer due poor literary. Majority of the vegetable growers personally involved in insecticide application but they are dependent on others for pest problem identification and selection of proper insecticide when the problem arises.

Different species of aphid, jassid, thrips, whitefly and fruit borer on brinjal, tomato chilli; okra and bean; aphid , whitefly and diamond back moth on cole crops; aphid, jassid, thrips, whitefly and red pumpkin beetle on cucurbite were found infesting the crops. Lady bird beetle and chrysopa were observed as natural enemies of above pest on most of the crops. Higher counts of all the insect pest and predators were observed in the month of December afterword it declined due to insecticide application in subsequent month.

The result of farm gate sample analysis for different vegetable showed that 80% brinjal, 60% tomato, 20% bean, 40% chilli, 40% okra and 40% cabbage samples were found contaminated with insecticide residue. The insecticide residue level detected for most of the contaminated samples had exceeded the MRL value.

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Table: 4.19 Status of insecticide residue on farm gate sample of brinjal crop.

Sr. No.	Site of collection	Date of collection	Date of last spraying	Status of insecticide	Safe waiting* period (days)	Residue level (mg/kg)	MRL ** (mg/kg)	Remark
1	Aarang	13/12/2009	10/12/2009	Endosulfan	5	2.36	2.0	Above MRL
2	Pirda	23/12/2009	15/12/2009	Not detected	–	–	–	–
3	Doma	30/12/2009	27/12/2009	Chloropyriphos	7	1.58	0.2	Above MRL
4	Kumhari	11/02/2010	06/02/2010	Endosulfan	5	0.98	2.0	Below MRL
5	Nadanvan	14/02/2010	12/02/2010	Malathion	4	4.67	3.0	Above MRL

*Safe waiting period and **MRL decided by AICRP on pesticide residue as published by Agnihotri, N.P. (1999).

Table: 4.20 Status of insecticide residue on farm gate sample of tomato crop.

Sr. No.	Site of collection	Date of collection	Date of last spraying	Status of insecticide	Safe waiting* period (days)	Residue level (mg/kg)	MRL ** (mg/kg)	Remark
1	Dateranga	29/12/2009	21/12/2009	Not detected	_	_	_	_
2	Bhatagaon	12/01/2010	08/01/2010	Chloropyriphos	8	0.87	0.2	Above MRL
3	Bhatagaon	17/01/2010	09/01/2010	Not detected	_	_	_	_
4	Kumahari	09/02/2010	07/02/2010	Endosulfan	7	3.25	2.0	Above MRL
5	Nadanvan	19/02/2010	11/02/2010	Endosulfan	7	0.59	2.0	Below MRL

*Safe waiting period given and **MRL decided by AICRP on pesticide residue as published by Agnihotri, N.P. (1999).

Table: 4.21 Status of insecticide residue on farm gate sample of bean crop.

Sr. No.	Site of collection	Date of collection	Date of last spraying	Status of insecticide	Safe waiting* period (days)	Residue level (mg/kg)	MRL ** (mg/kg)	Remark
1	Mujgahan	02/01/2010	23/12/2009	Not detected	_	_	_	_
2	Chandandih	01/02/2010	28/01/2010	Endosulfan	11	2.11	2.0	Above MRL
3	Kumahari	09/02/2010	31/01/2010	Not detected	_	_	_	_
4	Kumahari	11/02/2010	02/02/2010	Not detected	_	_	_	_
5	Nadanvan	17/02/2010	08/02/2010	Not detected	_	_	_	_

*Safe waiting period and **MRL decided by AICRP on pesticide residue as published by Agnihotri, N.P. (1999).

Table: 4.22 Status of insecticide residue on farm gate sample of chilli crop.

Sr. No.	Site of collection	Date of collection	Date of last spraying	Status of insecticide	Safe waiting period (days)	Residue level (mg/kg)	MRL * (mg/kg)	Remark
1	Mujgahan	02/01/2010	25/12/2009	Not detected	_	_	_	_
2	Bhatagaon	21/01/2010	12/01/2010	Not detected	_	_	_	_
3	Chandandih	02/02/2010	29/01/2010	Cypermethrin	3	0.67	0.5	Above MRL
4	Kumahari	13/02/2010	03/02/2010	Not detected	_	_	_	_
5	Nadanvan	25/02/2010	22/02/2010	Cypermethrin	3	0.83	0.5	Above MRL

*Safe waiting period and **MRL decided by AICRP on pesticide residue as published by Agnihotri, N.P. (1999).

Table: 4.23 Status of insecticide residue on farm gate sample of okra crop.

Sr. No.	Site of collection	Date of collection	Date of last spraying	Status of insecticide	Safe waiting* period (days)	Residue level (mg/kg)	MRL** (mg/kg)	Remark
1	Aarang	11/12/2009	03/12/2009	Not detected	_	_	_	_
2	Pirda	20/12/2009	11/12/2009	Not detected	_	_	_	-
3	Mujgahan	02/01/2010	31/12/2010	chloropyriphos	5	1.37	0.2	Above MRL
4	Bhatagaon	14/01/2010	03/01/2010	Not detected	_	_	_	_
5	Nadanvan	25/02/2010	17/02/2010	Endosulfan	4	0.83	2.0	Below MRL

*Safe waiting period and **MRL decided by AICRP on pesticide residue as published by Agnihotri, N.P. (1999).

Table: 4.24 Status of insecticide residue on farm gate sample of cabbage crop.

Sr. No.	Site of collection	Date of collection	Date of last spraying	Status of insecticide	Waiting* period (days)	Residue level (mg/kg)	MRL ** (mg/kg)	Remark
1	Aarang	17/12/2009	13/12/2009	chloropyriphos	10	0.43	0.2	Above MRL
2	Aarang	18/12/2009	08/12/2009	Not detected	–	–	–	–
3	Kumahari	13/02/2010	05/02/2010	Not detected	–	–	–	–
4	Nadanvan	11/02/2010	02/02/2010	Not detected	–	–	–	–
5	Nadanvan	14/02/2010	11/02/2010	Endosulfan	8	2.519	2.0	Above MRL

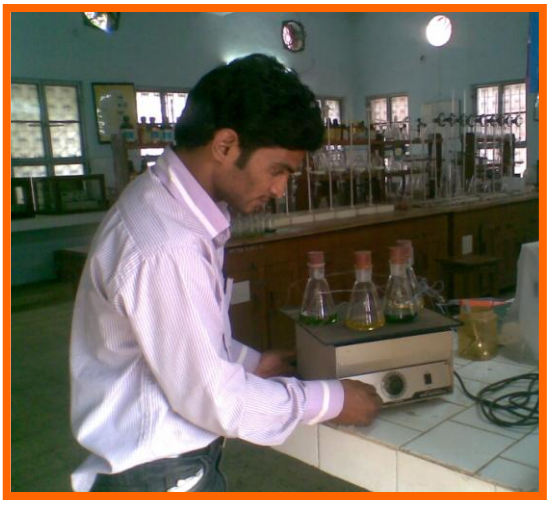
*Safe waiting period and **MRL decided by AICRP on pesticide residue as published by Agnihotri, N.P. (1999).

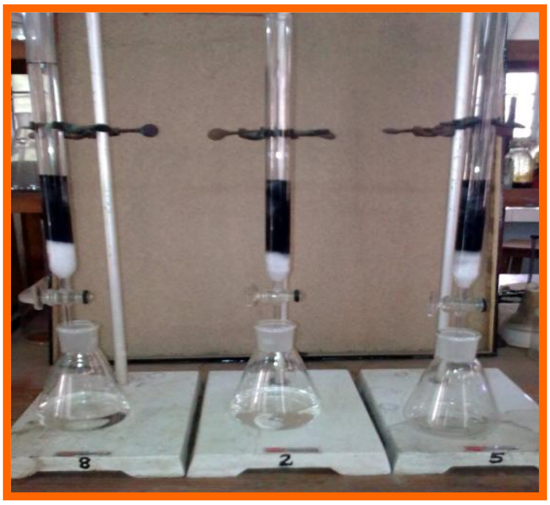
Plate No. 1 Vegetable growers interview regarding plant protection tactics






Plate No. 2 Farmers field view for different vegetable crops of Rabi season





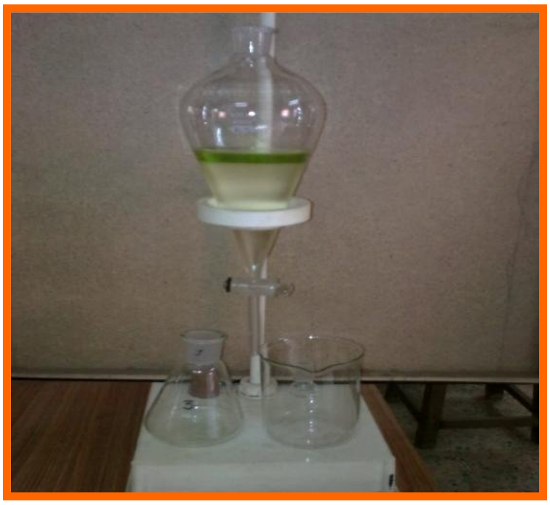
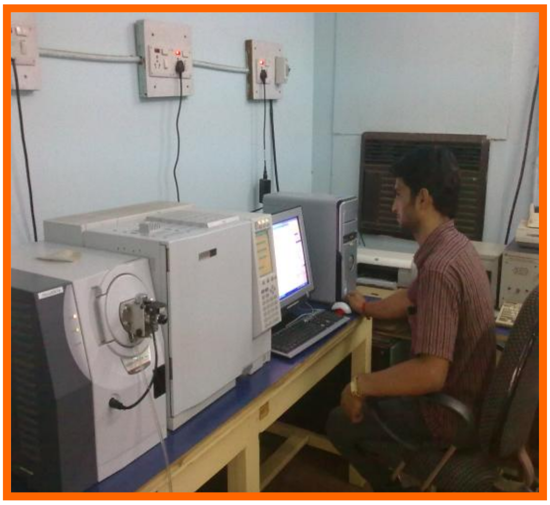


Plate No. 5 Extraction, Clean up & final determination process of insecticide residue analysis

Plate No. 3



Grading of freshly harvested vegetables in the vegetable farm

Plate No.4 Insect pest and predators of different vegetables