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Materials and Methods
The present study was conducted during 2008 to 2011 in three agro-climatic zones of Karnataka viz., Bangalore and Kolar-Eastern Dry Zone, Hubli-Dharwad-Northern Transition Zone and Belgaum-Northern dry zone. The adopted procedures and methods for the study are presented here. The entire study is divided into four parts. The three vegetables selected for the research are most important vegetable crops in these zones.

These zones were selected because, most of these farmers grow at least one or all the vegetables selected for the study. The area under the vegetables was considerably high in these zones.

Preliminary survey for the pest management practices adopted by brinjal, cabbage and tomato growers in selected villages of the 3 agro-climatic zones of Karnataka

The survey was carried out to know the pest control practices of the farmers for three vegetable crop viz., brinjal, cabbage and tomato. The procedure followed by Trivedi (1963) was used for the study with slight modification. The information was elicited from the respondents with the help of structured interview questionnaire and necessary corrections were made in the questionnaire. Copies of the structured questionnaire are furnished in Appendix 1 to 3. Data collection was made during August 2008 by personally interviewing the respondent vegetable growers of the selected locations. The help of officials of Department of Agriculture, Horticulture and input supply companies was taken to visit randomly selected villages in all three zones.

The questionnaire contains farmer's name, address, age and the education level, crops grown, area under different crops like brinjal, cabbage and tomato, number of times specific crop raised every year, knowledge about pest and diseases of these crops, information source, pest management methods followed, number of chemicals/insecticides sprayed during crop period and approximate cost per acre, level of satisfaction with chemical use, harmful effects of excessive use of chemicals, readiness to try newer and environmental friendly methods, etc. The farmers were grouped into three
categories based on age as used by Raghavendra (1979) with slight modifications. The procedure followed by Venkatesh Prasad (1995) was employed to measure the knowledge of the respondents with slight modifications. For other parameters like land holding, annual income and awareness, the methods followed by Angadi (1999), Sunil Kumar (2004) and Palanisamy and Sriram (2000) were followed accordingly.

The data from the survey were compiled to ascertain the awareness among the farmers about the IPM in major vegetables like brinjal, cabbage and tomato emphasising on the use of bio-pesticides, pheromones, etc. In all the three zones, the taluks selected were Bangalore rural, Doddaballapur, Devanahalli, Kolar, Chickballapur in Eastern Dry Zone (Bangalore-Kolar), Hubli, Dharwad, Kalgatagi in Northern Transition Zone (Hubli-Dharwad) and Gokak in Northern Dry Zone (Belgaum). From selected taluks, 50 farmers were selected randomly for each of the three vegetables viz., brinjal, cabbage and tomato. So sample size of each zone were 150 farmers and total sample size of preliminary survey includes 450 farmers. Frequency and percentages were used to explain the different variables.

Validations of bio-intensive integrated pest management (BIPM) module through farmer’s participatory approach on selected vegetable crops

For BIPM validations, method used by Krishnamurthy and Krishna kumar (2004) was followed. The methods adopted by Khader Khan et al. (1998), Chakraborti (2001), Singh et al. (2003) and Gajanana et al. (2006) were also utilized wherever applicable. Detail validation trial protocol format prepared (Appendix 9) and investigations on each of three crops were carried out in farmers fields in all the 3 zones during Summer, kharif and rabi seasons of 2008-2011. Validations started from the nursery stage itself. Biopesticides Trichoderma and Pseudomonas were mixed to seed bed mixture as per the recommendation and seedling death was observed a month after sowing. Those seedlings were taken by farmer and transplanted to the main field usually a month after sowing. In the main field, the IPM plot was divided into five blocks and same type of plot was selected in another isolated place (0.5 km distance) as non-IPM plot. In non-IPM plot, all the operations practiced by the farmer was recorded. Insecticides and other pesticides sprayed were also recorded (Appendix 10 and 11).
Figure 1: Study area under three zones of ten agro-climatic zones of Karnataka
In transplanted IPM plot, *Trichoderma*, *Pseudomonas*, *Beauveria bassiana*, NPV, pheromone traps and lures, shoot clippings, organic salt, etc. were used based on the crop. In non-IPM plot only chemical insecticides used were applied.

List of pests and diseases taken into an account during the trial period were seedling death (due to any soil borne fungal/bacterial/nematode/nutrients, etc.), sucking insects like aphids, white flies, hoppers and mites. Diamond Back Moth (DBM) and defoliator like *Spodoptera litura* in cabbage, brinjal shoot and fruit borer, *Leucinodes orbonalis* in Brinjal and fruit borer, *Helicoverpa armigera* in tomato. Some minor pests like leaf miners, root grubs, diseases like wilt, root rot, fruit rot, etc. were also taken into an account (Appendix 11 to 16).

Seedling death counts were taken both in IPM and non-IPM plots. Details of all pesticidal sprays in both the plots against various pests and diseases with dates and dosages were recorded. The population count of major pests like aphids, DBM, *Spodoptera litura*, *Helicoverpa armigera*, *Leucinodes orbonalis* were recorded based on crop by selecting 10 plants randomly from each of 5 replications of 2 treatments. Pre-spray counts were recorded as first date of observation and subsequently the counts of target pests/diseases were recorded. Taken the count before each spray and total 50 plants in each treatment. Record of air borne diseases like leaf spot, powdery mildew and downey mildews were also considered while taking observation. Disease rating was calculated based on estimated per cent infestation. This observation was taken once among the crop period, usually a week before final harvest. The damaged/infested plants count was taken, both in IPM and Non-IPM plot from total plants of each treatment plot after 5 replications (50 plants from each treatment). In case of brinjal, shoot clipping was also considered as one of the IPM components because no insecticide and Bio-pesticide could reach the target pest, *Leucinodes orbonalis*. The respective pheromone traps and lures were installed in IPM validation plot of respective crop and moth counts were taken every 4-7 days. No traps were installed in Non-IPM field.
Yield data

Yield data was taken by taking weight of total harvest in Kgs from both IPM and non-IPM plots in cabbage. But brinjal and tomato are harvested several times and for the purpose of Cost: Benefit calculation, considered only 4 months harvest yield. Farmers were given instructions to record the yield at each time they harvest the crop with dates. By adding up all the harvest data of different dates, total yield per acre was calculated.

Cost: Benefit estimation in IPM and non-IPM plots

The input costs, yield and return per acre and profit were calculated on the prevailing market rate of pesticides and the cost of product. In the present study the economics of IPM technology in vegetable cultivation was arrived at by computing the per acre cost and returns basis.

The gross returns, net returns and benefit: cost ratio was calculated by using the following formula

\[
\text{Gross returns (₹) = Actual yield of vegetables per acre} \times \text{market price (₹/t).}
\]

\[
\text{Net returns (₹) = Gross returns (₹)/acre} - \text{total plant protection cost/acre.}
\]

\[
\text{Cost : Benefit ratio (operational cost) - BCR} = \frac{\text{Net returns (₹ / acre)}}{\text{Total plant protection cost (₹ / acre)}}
\]

General note

All the agronomic practices except plant protection measures were followed as per recommended package of practices for the said zone (Anon., 2004). All the insecticides were selected as per the farmer choice. The required volume of the spray solution was prepared at the time of application. Spraying was initiated based on larval population and also based on farmers experience. Subsequent sprays were taken up at 5-7 days interval. All the sprays were taken up using high volume knapsack sprayer with 400-500 liters of spray fluid per hectare depending upon the age of the crop.
Cost of labour, crop cultivation, fertilizer cost if common and other expenses were considered as constant for both IPM and Non-IPM plots. The meteorological data like temperature and rainfall of all the zones for the trial period were also considered (Appendix 4, 5 and 6). Recommended instructions for the usage of plant protection products were followed for their application.

Six brinjal BIPM validation trials were conducted in three zones during 2008-2010. Each trial period varied from 6 to 8 months from sowing up to harvest. Half acre plot was considered for each treatment. Number of brinjal seedlings planted remained same in both plots and in all three zones.

Cabbage BIPM validation trials using bio-pesticides and pheromones were conducted in three fields in each zones. Overall nine cabbage BIPM validation trials were conducted in different seasons of the years 2009 and 2010. Six BIPM validation trials were conducted in tomato crop in three zones during 2009-11. Two validation trials in different seasons conducted in each zone.

Statistical analysis

The mean population of *P. xylostella* (DBM), *S. litura* (defoliator), *Leucinodes orbonalis* (BSFB), *Helicoverpa armigera* (Tomato fruit borer), sucking insects like aphids, white flies, hoppers and mites were computed.

Dissemination of the validated BIPM module among the vegetable growers

After the preliminary survey and IPM module validation trials using bio-pesticides and pheromones, several BIPM promotional activities were conducted in all the three agroclimatic zones. The major promotional activities conducted were, Farmers Training programmes, preparation of pest and disease fact sheets with management options, IPM component use support to few selected farmers and farmer field days. The method adopted by María Maceri *et al.* (2007) was helpful in deciding proper dissemination techniques that are to be adopted.
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Farmers Training Programmes

Six farmers training programmes were arranged in each of the three zones to educate them on validated technology. These programmes were conducted in coordination with Department of Agriculture, NGOs and Agri input and support companies. Only progressive farmers were selected for the training programmes.

Preparation and distribution of pest and disease fact sheets with management options

Major pest and disease fact sheets were prepared and distributed free of cost to the respondent farmers. All fact sheets prepared are illustrated in Appendix 11 to 16. Interested farmers were encouraged to use the validated IPM components. Field visits were undertaken and they were educated accordingly.

Farmer Field days

Based on the concept of “seeing is believing”, field days were organised in order to convince the farmers to adopt validated IPM module to manage pests and diseases of brinjal, cabbage and tomato in future. Taken the help of Byrapura Organic Farmers association, Nunhems seed company technical staff, Organic Food club-Yamakanamaradi, Mahyco seed company, local dealers and Seminis seed company in respective field days.

Assessment of the impact of adoption of the new BIPM module on the vegetable growers during the post-demonstration phase

This post study impact survey was conducted during 2011 in the study area to understand the impact of IPM activities including validation, demonstrations and promotions and also to understand the usefulness of the validated IPM module. Information on the adoption of the components of IPM was also collected. The schedule was administered in local language (i.e., Kannada) through structured questionnaire
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(Appendix 7) and the replies were recorded. The methods followed by Rogers (1968), Sivapragasam et al. (1985), Grieshop et al. (1988) and Gandhi et al. (2008) were also utilized for the survey.

Sampling and Population of the study

Hundred farmers were randomly selected from different villages of three zones where validations and demonstrations were conducted. Farmers were later categorized into IPM and non-IPM farmers based on their response to the interview. The vegetable growers who are in contact during IPM extension activities in those three zones constitute the population for the study. Selection of taluks and villages are same as in preliminary survey.

Category of the farmer

This refers to the plant protection practices adopted by the farmer to manage pests and diseases. The respondents were categorized into three groups as, Organic (Used only IPM methods), Chemical/Traditional (Used only Chemical pesticides) and Mixed (Used both IPM component and chemical pesticides). Scoring pattern followed was as per Trivedi (1963) with slight modifications.

Practice of IPM methods or use of IPM products

In the validated IPM module, few products and methods were listed. The farmers were asked to indicate methods followed and products used and individual responses were expressed in terms of percentages.

Some of the components of validated IPM package are as follows,

1. Use of Trichoderma and Pseudomonas for seed treatment, nursery drenching and FYM enrichment for soil application as per the recommendations.

2. Use of pheromone trap to monitor or mass trap Brinjal shoot and fruit borer or Spodoptera litura or Diamond Back Moth or Tomato fruit borer based on the crop.
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3. At least two sprays of Bio-pesticides viz., Organic salt formulation or *Beauveria bassiana* formulation or NPVs of tomato fruit borer or defoliators.

4. Use of organic salt/botanicals @ 5 ml/litre.

5. Physical removal of affected fruits and plant parts i.e., clipping of Brinjal shoots.

6. Use of any other local IPM techniques/methods.

The farmers were post-stratified as IPM and non-IPM farmers, depending on whether they followed the IPM practices or not. The method suggested by Supe (1969) and Kolte (1974) was also followed with necessary modifications. They were asked to indicate pests and diseases against which they used validated IPM products and practices. The responses were expressed in terms of percentages. Questions were also asked to the farmers to know, whether they followed IPM practices as per recommendation in terms of time of the day, dosage and crop stage. To understand whether the farmer was satisfied with the validated IPM technology on these three vegetables. He was given 3 categories of choices namely completely satisfied (excellent), partially satisfied (fair) and dissatisfied (poor) and percentages were calculated accordingly. In order to understand whether the farmer was ready or not interested to continue the IPM practice, he was given four categories of choices viz., ready, partially ready with conditions and not ready at all. Accordingly, percentage response was calculated.

To know the problems faced by the vegetable growers in adoption of IPM practices in brinjal, cabbage and tomato crop, the respondents were asked to indicate the problems and the responses were recorded. Thus, obtained responses were expressed in terms of frequency and percentage. Just to know the pest management methods followed other than validated IPM practices, farmers were asked to list the same and analysed based on the percentage response from farmers.
Sources of information

This was to understand the effectiveness of IPM demonstrations and trainings and also to understand the other sources of information for the farmers to take up pest management practices. Individual response towards different sources of information were expressed in terms of percentages. Farmers response towards the most liked IPM component of validated IPM module on three different vegetables and were expressed in percentages.

Finally, suggestions were asked from the farmers on improvement of IPM practice in general and use of bio-pesticides and pheromones in particular. Their response towards each suggestions were expressed in percentage. Statistical tools such as mean, standard deviation, frequency and percentages were employed wherever found appropriate in order to tabulate and analyse the data to draw valid inference.