



## Do vegetable growers really follow the scientific plant protection measures? An empirical study from eastern Uttar Pradesh and Bihar

SHUBHADEEP ROY<sup>1</sup>, JAYDEEP HALDER<sup>2</sup>, NEERAJ SINGH<sup>3</sup>, A B RAI<sup>4</sup>, R N PRASAD<sup>5</sup> and B SINGH<sup>6</sup>

ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh 221 305

Received: 16 April 2016; Accepted: 26 July 2017

### ABSTRACT

Insect pest and diseases are the major biotic constraints to vegetable production in India as they accounted about 10-30 per cent of crop losses in the country. To manage these biotic stresses, Indian farmers commonly rely up on spraying of synthetic/chemical pesticides. However, there are huge gaps between recommended scientific packages of practices and actual pesticide use pattern by the vegetable growers. This study was designed to identify those gaps in the districts of eastern Uttar Pradesh and Bihar, considered as a prominent vegetable growing belt of the country. Data were collected from 200 progressive vegetable growers with a structured questionnaire covering different aspects of plant protection measures. The results alarmingly depicted that 88.5% respondents applied overdoses of pesticides (with cumulative score 452) in vegetables and 87.2% did not even bother about any personal safety measures while spraying pesticides (cumulative score 441). The majority of the respondents (76.8%) used to spray pesticides during noon hours of the day, which enhances the chances of health hazards and not getting desired results from the spray. Farmers have very low level of knowledge about the toxicity colour code and container disposal techniques after use of pesticides. Other important plant protection issues have been ranked by the respondents as per their perceived priority like unawareness about the label claim (cumulative score 436), frequent application of pesticides without referring ETL (cumulative score 435). As the waiting period is not followed by the most of the farmers (cumulative score 427), the problem of pesticide residues is becoming severe. Non-availability of suitable bio-control agents in the market (cumulative score 433) and lack of knowledge about their usage further hinder their adoption. This paper envisages to flag the issues of grass root problems and will help to formulate future policies to control the faulty use of chemical pesticides and will act as a guiding principle for the safe and judicious use of pesticides.

**Key words:** Farmers' perception, Knowledge gap, Pest management, Vegetable growers

After green revolution, use of pesticides almost became inevitable for crop production in India. Introduction of high yielding varieties (HYV), applying inorganic fertilizers and use of chemical pesticides were considered as three pillars for enhanced production to feed the nation. But the indiscriminate and injudicious uses of pesticides have led to many problems like resistance to insecticides, resurgence of target insects and secondary pest outbreak, in addition to insecticide residues in food and beverages, contamination of groundwater, adverse effect on human health, and widespread killing of non-target organisms (Werf 1996, Berny, 2007, Halder *et al.* 2012, 2014). Apart from these, exposure to pesticides and its residue might cause a number of accidental poisonings, and even the routine use of pesticides may pose serious health hazards to farmers

both in the short and the long run. In many developing countries, farmers face great risks of exposure due to the use of toxic chemicals that are already banned or restricted in other countries accompanied with improper application techniques, poorly maintained or totally inappropriate spraying equipment, inadequate storage practices, and often reuse of old pesticide containers for food and water storage (Ecobichon 2001, Ibitayo, 2006, Asogwaand Dongo 2009). By their very nature most pesticides show a high degree of toxicity because they are designed to kill certain organisms and thus create some risk of harm. Even farmers who were well aware of the harmful effects of pesticides are sometimes unable to translate this awareness into their practices. Various inappropriate practices in the use of pesticides cause possible poisoning symptoms generally among farmers who do not wear protective clothing (Yassin *et al.* 2002, Salameh *et al.* 2004). On this backdrop, present study was designed to assess the pesticide use behavior/pattern of the vegetable growers, mainly from the eastern part of the country, so that, the actual gap between the scientific recommendations and farmers' perceptions, if any, can be worked out. This will also help to orient to formulate future policies to control

<sup>1</sup>Scientist (e mail: shubhadeepiari@gmail.com), <sup>2</sup>Scientist (e mail: jaydeep.halder@gmail.com), <sup>3</sup>Principal Scientist (e mail: neerajatic@gmail.com), <sup>4</sup>Head and Principal Scientist (e mail: abraiivr@gmail.com), <sup>5</sup>Head (In-charge) and Principal Scientist (e mail: mrprasad\_zcu@yahoo.co.in), <sup>6</sup>Director (bsinghiivr@gmail.com)

faulty use of chemical pesticides as well as future farmers' training programmes to motivate the vegetable growers of the region towards the judicious use of pesticides and the adoption of the alternative methods of pest control such as integrated pest management (IPM).

#### MATERIALS AND METHODS

A structured schedule was developed to collect data on pesticide use behavior/pattern of the vegetable growers. Data was collected from a total 200 vegetable growers of Bihar and eastern Uttar Pradesh who visited ICAR-Indian Institute of Vegetable Research, Varanasi for different training programmes or exposure visits, annual *Kisan Mela* conducted during the year 2014-2016. The vegetable growers were from the districts of Nalanda, Muzaffarpur and Nawada of Bihar and the districts of Varanasi and Mirzapur of eastern Uttar Pradesh. From each district two villages were selected and from each village 20 vegetable growers were selected randomly as respondents. The vegetable growers were interviewed with the help of the structured schedule consisted of different aspects of pesticide use behaviour/pattern as well as group discussion method. A questionnaire covering different plant protection aspects such as farmers' perception about pesticide residue in/on vegetables, adoption of safety measures during pesticide application, the role of biocontrol agents in pest management, waiting period of pesticides, their knowledge about IPM etc. were gathered from the farmers. A five-point continuum index was constructed to identify the rank wise priority in different plant protection issues to address in vegetable sector.

#### RESULTS AND DISCUSSION

The socio-personal profile of the vegetable growers has been depicted in Table 1 and represents their personal and family details, experience in vegetable cultivation and extent of cosmopolitaness.

A series of statements about pesticide use was produced before the vegetable growers and were asked to respond with 'yes' or 'no' and the result is represented in Table 2. Only 7.3% respondents performed seed treatment before sowing. Though all the respondents faced weed problem in their vegetable fields, however, only 2.5% of them used any herbicides for controlling weeds. About 97.5% vegetable growers were found deploying family labour for weeding and was convinced more economic than investing in pre-emergence herbicides. About 88.5% vegetable growers did not follow about the prescribed dose(s) when applying pesticides which not only increased the cost of inputs, but also leading to the development of resistance in pest and pathogens against those formulations. Many vegetable growers were unaware/reluctant about personal safety measures when spraying pesticides as only 47.5% respondents took an immediate bath after applying pesticides, whereas only 12.8% cover their face and body properly when spraying. Using proper nozzle is very important to get the desired result from spraying. Only 2.8% respondents used proper nozzles when spraying different pesticides, viz.

Table 1 Socio-personal profile of the vegetable growers

Attributes	Category	Percentage
Age	i.35 years and below	23.7
	ii.36 to 58 years	46.3
	iii.59 years and above	30.0
Education	i. Illiterate	26.3
	ii.Functionally literate	13.8
	iii.Primary school	17.5
	iv.Secondary school	33.6
	v.College graduate	8.8
Social participation	i.Non-members	25.0
	ii.Member in the past	2.5
	iii.Office bearer in past	16.3
	iv.Member at present	26.2
	v.Member at present and Office bearer in past	20.0
	vi.Office bearer at present	10.0
Experience in vegetable cultivation	i.Up to 1 year	22.5
	ii.1 to 5 years	38.7
	iii.5 years and above	38.8
Land holding	i.Marginal (upto 10 biswa*)	52.5
	ii.Small (10 to 20 biswa)	31.3
	iii.Medium (1 to 3 bigha**)	15.0
	iv.Big (More than 3 bigha)	1.2
Area under vegetable crops	i.Cultivated less than ½ area	22.5
	ii.Cultivated on about ½ area	28.8
	iii.Cultivated more than ½ area	48.7
Family members	i.Up to 5	43.7
	ii.More than 5	56.3
Sources of income	i.Farming alone	40.0
	ii.Farming related activities	18.7
	iii.Farming + vegetable trading	41.3
Personal localite contact	i.Rarely	20.0
	ii.Sometimes	40.0
	iii.Frequently	40.0
Extension agency contact	i.Rarely	31.3
	ii.Sometimes	33.7
	iii.Frequently	35.0
Mass media exposure	i.Never	11.3
	ii.Occasionally	63.7
	iii.Frequently	25.0

\* Biswa is a local land measurement unit comprising of 126.3 sq meter. \*\* 1 Bigha = 18-20 biswa

insecticides, fungicides and herbicides. Considering the harmful effect of pesticide application, 42.5% vegetable growers revealed that they did not consume the same vegetables that they used to cultivate for commercial purpose and 65% had kitchen garden for the family consumption. 98.5% respondents did not have any knowledge about the antidote of the pesticides and 78% vegetable growers used to prefer spray pesticides in vegetables after harvesting.

Proper timing of spray is essential for successful pest and disease control. Every pesticide use has its own timetable, but within that schedule, the best way to maximize

Table 2 Response of the vegetable growers upon the statements on pesticide use

Statements	Yes (%)	No (%)
Do you treat your seed before sowing?	7.3	92.7
Do you face weed problem in your field regularly?	100	
Do you use herbicide for controlling weed at your field?	2.5%	97.5%
Do you use pre-emergence herbicides for controlling weeds?	2.5%	97.5%
Do you apply pesticides as per dose prescribed on its container?	11.5	88.5
Do you take a proper bath after spraying pesticides?	47.5	52.5
Do you cover your face and body properly at the time of spray?	12.8	87.2
Do you wash your sprayer properly after spraying pesticides?	57.5	42.5
Do you use different nozzle for spraying different pesticides (insecticides, fungicides, herbicides)?	2.8	97.2
Do you eat the same vegetables cultivated for commercial purpose?	57.5	42.5
Do you have a kitchen garden for family consumption?	65	35
Do you have knowledge about the antidotes of pesticides?	1.5	98.5
Do you prefer to spray pesticides in vegetables after harvesting?	78	22

effectiveness is by applying chemicals at the right time. Plants absorb water better early in the morning or around dusk. Stomata are open during these hours, absorbing water vapor and dew during the coolest time of the day and when sunlight is not stimulating food production through photosynthesis (<http://homeguides.sfgate.com>). Many insects are most active early in the morning and around dusk, making very early morning and evening the most effective times for insecticide application. Insecticides can have undesirable consequences if they are applied at the wrong time. According to the National Gardening Association, application of an insecticide like Carbaryl to shrubs needed to be restricted to between late evening and very early morning hours to avoid poisoning beneficial insects like bees. In this regard, the farmers were asked to response over their timing of spray to control pest and diseases in vegetables, 76.8% of the vegetable growers revealed that, they used to spray pesticides at noon hours (Table 3), which is not a proper time for spraying and may be one of the reasons of not getting desirable results from the spray as well as chances of high health hazards.

In this context, it is imperative to be aware of the meaning of different colour codes depicted on the pesticide containers. These colours represent the toxicity level of the pesticides and the extent of caution should be taken while handling those products. Amongst the respondent

Table 3 Distribution of the farmers as per the time of spray they used to follow

Time of spray pesticides	Respondents percentage
Morning (5.00 AM to 10.00 AM)	2.5%
Noon (10.00 AM to 4.00 PM)	76.8%
Afternoon (4.00 PM to 7.00 PM)	20.7%
Night (7.00 PM to 5.00 AM)	Nil

Table 4 Farmers' perception about the meaning of different colour code on the pesticide container

Colour code	Correct (%)	Wrong (%)
Red (Extremely toxic)	58.5	41.5
Yellow (Highly toxic)	25.25	74.75
Blue (Moderately toxic)	40.75	59.25
Green (Slightly toxic)	49	51

Table 5 Dispose patterns of pesticide containers by the farmers

	Throw in the crop field (%)	Bury in soil (%)	Collect in common house place (%)	Collect in isolated place (%)
Plastic packet	88.3	3.5	5	3.2
Heavy plastic container	1.5	nil	68	30.50
Metal container	nil	nil	71.6	28.40

vegetable growers only 60%, 25%, 40% and 50% knew the exact meaning of the red, yellow, blue and green colour, respectively (Table 4).

Disposal of pesticide container is another important aspect after using the pesticides. If it is not disposed properly, it may contaminate the environment and the result could be very lethal. One burning example is recent mid-day meal tragedy in Bihar. On 16 July 2013, at least 23 students died and dozens more fell ill at a primary school in the village of Dharmashati Gandaman in the Saran district of Bihar after eating a mid-day meal contaminated with pesticide ([https://en.wikipedia.org/wiki/Bihar\\_school\\_meal\\_poisoning\\_incident](https://en.wikipedia.org/wiki/Bihar_school_meal_poisoning_incident)). The disposal patterns of the pesticide containers have been represented in Table 5.

From the Table 6 it is evident that amongst the different priority parameters in the area of plant protection, environmental pollution and increased cost of cultivation due to application of overdose of pesticides by the vegetable growers ranked first as the majority of the vegetable growers (65%) considered as 'most important' and thereby securing maximum cumulative score of 452. The second most priority parameter with cumulative score of 446, as perceived by the vegetable growers, was pesticide residue(s) in/on vegetables that may lead to serious health hazards to the final consumers where about 67% vegetable growers considered as 'most important' followed by 19% who thought as 'important' parameter in their daily life. A study in Telangana by Kumari *et al.* (2016) indicated that persistence of some pesticides was known to the majority of the farmers (67%). Ignorance

Table 6 Percent distribution of the vegetable growers categorized priority parameters in plant protection

Priority parameters	5*	4	3	2	1	Cumulative score	Rank
Environmental pollution and increased cost of cultivation due to application of overdose of pesticides by the farmers.	65	24	8	3	0	452	1
Pesticide residue(s) in/on vegetables may lead to serious health hazards to the final consumers in the long run.	67	19	9	3	2	446	2
Due to ignorance or unawareness farmers don't take proper safety measures during and after pesticide spray.	56	33	8	2	1	441	3
Farmers use the same pesticides irrespective of crops grown (i.e. farmers don't have knowledge about label claim).	51	36	11	2	0	436	4
Use of non-recommended pesticides.	51	36	11	2	0	436	4
Frequent application of pesticides without referring ETL.	54	31	11	4	0	435	5
As a result of indiscriminate pesticides application pests and diseases are developing resistance to the same pesticides.	49	40	8	2	1	434	6
Non-availability of suitable bio control agents in the local market and lack of knowledge about their usage.	48	40	9	3	0	433	7
The waiting period is not followed after pesticide application.	49	37	8	4	2	427	8
Due to climate change and/or changing in cropping pattern minor pests may become major pests in the near future and the occurrence of new emerging pests.	49	37	8	4	2	427	9
Application of non-recommended mixture of pesticides.	49	31	15	4	1	423	10
Plant protection advices given by local dealers/commercial channels/fellow farmers.	40	48	7	1	4	419	11
Farmers do not use recommended volume of water when applying pesticides.	41	37	16	1	5	408	12
Variation or lack of harmony in pesticide recommendation by different government and non-government agencies.	36	40	19	4	1	406	13
Use of the same type of equipment(s) for failure/soil drench.	21	43	24	7	5	368	14
Application of non-recommended chemicals + biocontrol agents in a tank mix.	24	32	23	16	5	354	15
Application of herbicides for weed management is less preferred by the farmers.	13	49	15	13	10	342	16

\* Score = Most important (5), Important (4), Undecided (3), Less important (2), Not so important (1)

or unawareness often leads them not to take proper safety measures during and after pesticide spraying was judged by the vegetable growers as third most priority (cumulative score of 441) where 56 and 33 percent ranked them as 'most important' and 'important', respectively. In another study in Bangladesh, reported that 98 per cent of those that apply pesticides felt dizzy afterwards. There are several reports emphasizing the ill effects of pesticides associated with acute health problems for workers who handle the chemicals (Soares and Porto, 2009, McCauley *et al.* 2006, Beseler *et al.* 2008). During the interactions it has been observed that lack of knowledge about the label claim of pesticides lead to the use of the same pesticides irrespective of crops were grown as well as use of non-recommended pesticides jointly ranked fourth most important priority criteria. Modern insect pest management practices relied upon economic threshold level (ETL) rather than a calendar or scheduled based application. Lack/inadequate knowledge about ETL often tend to frequent application of pesticides resulting development of resistance to pests and diseases to the same chemicals which perceived fifth and sixth most priority by

the vegetable growers. Harmful effects of indiscriminate use of pesticides are reported by several researchers (Foster *et al.* 2002, Parker *et al.* 2003, Halder *et al.* 2013). To get rid of from the unintentional and associated problems of chemical pesticides, biological control measure is one of the green and safe technology for pest management, which is getting attention worldwide (Halder *et al.* 2015, 2017). During the interaction, many vegetable growers addressed that they do not have enough knowledge about the pesticides, including biocontrol agents while some of them confessed that non-availability of suitable biocontrol agents in the local markets further rendered them from using this green technology. They ranked this as their seventh priority with a cumulative score of 433 where 48% of the vegetable growers considered as most important and 40% recognized it as important. Other parameters like not following proper waiting period after chemical spraying, climate change and/or changing in cropping pattern adhered minor pests to become major pests and subsequent occurrence of new emerging pests, application of non-recommended (tank) mixture of pesticides and plant protection advices given by

local dealers/commercial channels/ fellow farmers rather than the plant protection experts were the eighth, ninth, tenth and eleventh most priority by the farmers, respectively. Present finding is in accordance with study of Kumari *et al.* (2016) who reported that thirty eight per cent farmers in Kothapally and 50 per cent in Enkepally in Telangana got their plant protection advices from pesticide dealers. In their response, vegetable growers also said that they often did not use recommended spray volume during pesticide application. Similarly, many times they got confused with the disharmony in pesticide recommendations by the different government(s) and non-government agencies. So, they also considered these in their priority list but with a lower cumulative score (406). Amongst all the sixteen plant protection priority parameters, application of herbicides for weed management ranked last with a cumulative score of 342 by the vegetable growers of the region followed by application of non-recommended chemicals + biocontrol agents in a tank mix (354).

Majority of the farmers of the region were not aware of the economic importance of various pests in their crops and they apply chemical pesticides immediately. Although the farmers are using pesticides more frequently, even higher than the recommended doses, the control is not up to the extent. This could be either the use of non-recommended pesticides or the selection pressure of pesticides on the pests causing resistance among the target population. From the present study, it is also evident that there are huge gaps between the farmers' perception about the pest control and recommended methods of package and practices. To address these gaps, proper farmers' training about the safe and judicious use of pesticides should be initiated. Implementations of IPM strategies in agriculture to reduce toxic pesticides in the environment as well as to enhance the productivity of healthy products are the need of the hour. We, further, aim to conduct a detailed study to explore the possible factor(s) and reason(s) that refrain the farmers from adopting the latest technical know how about the plant protection measures.

#### ACKNOWLEDGMENTS

Authors are extremely thankful to the farmers of the districts Varanasi and Mirzapur of Uttar Pradesh and districts Nalanda, Newada and Muzzafarpur of Bihar for sharing their valuable experiences in the field of plant protection. Authors also wish to thank the Director, ICAR-IIVR, Varanasi, Uttar Pradesh for providing necessary facilities and help.

#### REFERENCES

- Asogwa E U and Dongo L N. 2009. Problems associated with pesticide usage and application in Nigerian cocoa production: A review. *African Journal of Agricultural Research* **4**: 675–83.
- Berny P. 2007. Pesticides and the intoxication of wild animals. *Journal of Veterinary Pharmacology and Therapeutics* **30**: 93–100.
- Beseler C L, Stallones L and Hoppin J A. 2008. Depression and pesticide exposures among private pesticide applicators enrolled in the Agriculture Health study. *Environmental Health Perspectives* **116**: 1713–9.
- Ecobichon D J. 2001. Pesticide use in developing countries. *Toxicology* **160**: 27–33.
- Foster S P, Denholm I, Devonshire A L. 2002. Field-simulator studies of insecticide resistance to dimethyl carbamates and pyrethroids conferred by metabolic- and target site-based mechanisms in peach-potato aphids, *Myzus persicae* (Hemiptera: Aphididae). *Pest Management Sciences* **58**(8): 811–6.
- Halder J, Rai A B and Kodandaram M H. 2013. Compatibility of neem oil and different entomopathogens for the management of major vegetable sucking pests. *National Academy Science Letters* **36**(1): 19–25.
- Halder J, Rai A B and Kodandaram M H. 2014. Parasitization preference of *Diaeretiella rapae* (McIntosh) (Hymenoptera: Braconidae) among different aphids in vegetable ecosystem. *Indian Journal of Agricultural Sciences* **84**(11): 1431–3.
- Halder J, Srivastava C, Dhingra S and Dureja P. 2012. Effect of essential oils on feeding, survival, growth and development of third instar larvae of *Helicoverpa armigera* Hubner. *National Academy Science Letters* **35**(4): 271–6.
- Halder J, Rai A B and Dey D. 2015. Occurrence of *Phenococcus solenopsis* (Tinsley) in vegetable ecosystem and host-mediated effects on its dominant parasitoid, *Aenasius bambawalei* Hayat. *Vegetable Science* **42**(2): 30–3.
- Halder J, Kushwaha D, Rai A B, Singh S and Singh B. 2017. Potential of entomopathogens and neem oil against two emerging insect pests of vegetables. *Indian Journal of Agricultural Sciences* **87**(2):220–4.
- <http://homeguides.sfgate.com/time-day-spray-shrubs-44141.html>, accessed on 09.04.2017, 18:01 hrs
- [http://en.wikipedia.org/wiki/Bihar\\_school\\_meal\\_poisoning\\_incident](http://en.wikipedia.org/wiki/Bihar_school_meal_poisoning_incident), accessed on 09.04.2017, 18:09 hrs
- Ibitayo O O. 2006. Egyptian rural farmers' attitudes and behaviors regarding agricultural pesticides: Implications for pesticide risk communication. *Risk Analysis* **26**: 989–95.
- Kumari B R, Rao G V R, Sahrawat K L, Rajasekhar P, Rao V R and Wani S P. 2016. Farmers' perception of plant protection in Ranga Reddy District of Telangana, India. *Indian Journal of Plant Protection* **44**(2): 217–21.
- McCauley L A, Anger W K, Keifer M, Langley R, Robson M G and Rohlman D. 2006. Studying health outcomes in farm worker populations exposed to pesticides. *Environmental Health Perspectives* **114**: 953–60.
- Parker W E, Howard J J, Foster S P and Denholm I. 2006. The effect of insecticide application sequences on the control and insecticide resistance status of the peach-potato aphid, *Myzus persicae* (Hemiptera: Aphididae), on field crops of potato. *Pest Management Sciences* **62**(4): 307–15.
- Salameh P R, Baldi I, Brochard P and Abi Saleh B. 2004. Pesticides in Lebanon: A knowledge, attitude, and practice study. *Environmental Research* **94**: 1–6.
- Soares W L and Porto M F D. 2009. Estimating the social cost of pesticide use: An assessment from acute poisoning in Brazil. *Ecological Economics* **68**: 2721–8.
- Werf H M G. 1996. Assessing the impact of pesticides on the environment. *Agriculture, Ecosystems and Environment* **60**: 81–96.
- Yassin M M, Abu Mourad T A and Safi J M. 2002. Knowledge, attitude, practice, and toxicity symptoms associated with pesticide use among farm workers in the Gaza Strip. *Occupational and Environmental Medicine* **59**: 387–93.