Eco. Env. & Cons. 28 (May Suppl. Issue) : 2022; pp. (S551-S557)

ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2022.v28i03s.081

Pesticide consumption and investigation of usage patterns, handling practices, farmer's education, perception on pesticide use, and biological response of earthworms to dichlorvos

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(Received 14 January, 2022; Accepted 26 February, 2022)

ABSTRACT

Acute toxicity and morphological modifications of dichlorvos to *Eisenia foetida* were assessed by direct contact test via a filter paper. The 24 and 48 h LC50 were 70 and 50 ppm, respectively. Morphological Observations demonstrated body ruptures and bloody injuries. The pattern of pesticide usage, management, their health effects on farmers, and farmers perception towards pesticides was also studied. Data were collected viaa structured questionnaire, formal and informal interviews, and group discussions. The results point out that pesticides are readily available and extensively applied in crop cultivation. The primary purpose of presenting pesticides in the crop fields was to forestall and control pests and diseases. Organophosphates were the most generally utilizedpesticides by farmers. Farmer's reported manual application as the method of choice for pesticide application, and most of the farmers confirmed that no essential safety measures and precautions were embraced when pesticides were applied. Education was witnessed to influence the farmer's approach towards taking appropriate protective measures; however, there was no association between farmer'sage and pesticide health effects. The level of education and an alphabetic contributed significantly to poor awareness of pesticide use. The configuration of pesticideuses among farmers, therefore, needs improvement.

Key words : *Morphology, Hazardous, Health effects, Pesticide*

Introduction

Pesticides are applied widely all over the world, including developing countries like India, especially after the green revolution. The utilization of pesticides has inexorably abridged the influence of insect pests and improved agricultural production (Dar *et al.,* 2019). However, the insect pests get adopted to these pesticides progressively and become tolerant towards them (Kataria and Khan, 2016). As a result, crop growers are supposed to go for overuse of pesticides in terms of amount, quality, and a mixture of different chemicals turns out to be their favored approaches (Crissman *et al.,* 1994). The extensive and indiscriminate utilization of these chemicals degrade the health of the environment, become bioaccumulated, and puts forth a detrimental effect on human health (Dar *et al.,* 2020; Kumar *et al.,* 2018). The critical ecological activities like cycling of nutrients, soil organization, fertility, biodiversity, the natural balance of pests and predators are also influenced by pesticides (Stoytcheva, 2011). The primary concern related to pesticides is their harmful impact on human health upon exposure through oral, inhalation, and dermal routes (Abhilash and Singh, 2009). Pesticides utilized in agriculture induce morphological, behavioural, and physiological changes in many soil organisms generative, nervous, respiratory,and osmoregulatory organs and cause soil contamination that has a detrimental effect on different invertebrates (Mangala *et al.,* 2009). However, insecticides are the most lethal toxic pesticide class among the various pesticide groups and pose a danger to non-target species (Mahmood, 2016). The residues of insecticides have been reported from different ecotypes like cropping fields, water bodies, vegetables, human body fluids, etc. (Dar *et al.,* 2020). Earthworms, the key component of soil macrofauna and most important soil invertebrate responsible for the development and maintenance of soil nutritional value by transforming biodegradable materials into nutrient-rich vermicast (Kaushal *et al.,* 1995). The amazing services given to the environment by the earthworms are somehow at risk, and nowadays, research finding is focused on understanding the earthworms and their responses to pesticides. Dichlorvos, an organophosphate insecticide widely utilized for agricultural purposes,is highly toxic to earthworms (Ogunwole *et al.,* 2018).

The education level of farmers plays a significant role in agriculture-related activities because it broadens their vision and provides them exposure towards numerous aspects and occasions associated with agriculture, predominantly Pesticide and stewardship of the environment. understanding the causes that affect the perception, practices, and knowledge of farmers is essential for scheming effective management plans and policies (Shetty *et al.,* 2010). Hence, studies related to agricultural activities for pesticide use and their impacts on the environment and human health are crucial for policy framing creation of awareness related to agricultural practices (Deviprasad *et al.,* 2015) intending to develop harmless, safe, and sustainable agronomic practices (Tyagi *et al.,* 2015). The survey is a significant data collection process for evaluating the requirements of proposed recipients to determine their information and insight into the pest problem (Shetty *et al.,* 2010).

Keeping in mind the above-mentioned issues, the current study was undertaken to evaluate the different aspects of pesticide application patterns, views of farmers, knowledge, and management of pesticides as well as their impacts on farmer's health in some villages of Ajmer district, Rajasthan, India. Besides, this study also examined the acute toxic effects of dichlorvos using the method of paper contact under laboratory conditions with special reference to earthworm morphology.

Chemical and earthworms

Dichlorvos 76% EC (Dodak, Heranba Industries Ltd.) utilized in the toxicity assay was obtained from the local market, and stock solutions were prepared in acetone. The earthworms, *Eisenia foetida* were collected from a vermicomposting site near Harmara village, Kishangarh, Ajmer, Rajasthan, India. Within an hour, they were meticulously brought to the laboratory with moist vermicompost and soil. Prior to testing, earthworms were acclimatized in feed boxes containing a layer (4 inches) of uncontaminated soil at the bottom, a thin leaves layer, 12 inches of cow dung (meshed) plus soft soil (1:1), and a slim top layer of dried grass for a week under laboratory conditions. Wet gunny sacks were placed on the feed boxes as a cover to maintain the moisture.

Determination of median lethal concentration (LC50)

The acute toxicity experiments were performed by the direct (24 and 48 h) contact tests using standard filter paper method as recommended by Organization for Economic Co-operation and development (OECD) Guidelines-207, 1984. Briefly, instead of a flat-bottomed glass vial, petri-dish with 60 1mm x 15 mm size was used for the free movement of the test organism. Petri-dishes were lined without overlapping with Whatman filter paper no 1, covered with a lid that was punched for small ventilation holes with needles. Different concentrations of test pesticide (dissolved in acetone solvent) were loaded with 1 ml of 10, 30, 50, 70, and 100 µl L-1 solution on filter paper, followed by rotating the plates horizontally to ensure that the test chemical was distributed evenly. In parallel to the carrier solvent alone, controls were also run. 1ml of double distilled water was applied to each plate for moisture after drying. Earthworms were put on moist filter paper for 2-3 h prior to exposure to adapt to the test environment during starvation. Then earthworms were distributed randomly into groups of 15 earthworms for every treatment and exposed (1 earthworm per petri-plate; 7.527+0.35 cm in length and 250+0.25 mg in weight) to different concentrations of dichlorvos as described above and covered with a punched lid. Tests were performed for 24 and 48 h in the dark at 30 + 2 °C. The mortality percent of earthworms at each concentration of the test chemical was reported after 24 and 48 h, and the median lethal concentration (LC50) was calculated using the data.

Study site (survey)

The survey was carried out in the Kishangarh, Mundoti, and Bandarsindri areas of Ajmer district of Rajasthan, India. The study areas were chosen based on intensive farming activities, pesticide usage, level of farmer's involvement in agricultural practices, and the willingness of farmers to take part in the study. The study was carried out from November 2018 to April 2019. The collection of primary data (interviews and surveys) was from farmers, agricultural laborers, and pesticide vendors. Farmers were selected haphazardly from each village, and respondents were mostly farm proprietors who were associated with agricultural activities.

Data collection

Farmers with different levels of education were selected randomly to collect the information necessary for the present study. To avoid any biases in responses and get a real insight into agricultural practices, the respondents were not informed before the interview. However, the farmers were explained and clarified with the purpose behind the study at the interview time. Interviews were carried out in the local language for better understanding, and verbal consent wasobtained from all the respondents. Data were collected through a structured questionnaire, interviews, and discussions. The questionnaire was mainlyintended in closed question form, either in a multiple-choice format or with yes/no as answers and some questions which demanded multiple answers. All the collected data and information were then made for further analysis.

Questions were first linked to farming and sociodemographic characteristics of farmers. Secondly, farmers were questioned about the constraints they face in production and awareness about the time of pest infestation as well as control measures, they employ. Finally, they were asked about pest management awareness through education and training.

In viewofthe present study objectives, a questionnaire format comprising of the following three segments wasprepared, and information was gathered by intervening with the farmers independently. Section I: Personal information of farmers (Name, address, age, education). Section II: Pesticide purchase and instructions (Pesticide application history, buying sites, any consultation regarding pesticides, seal and labels, application frequency, crops on which pesticides are applied, alternate farming). Section III: Pesticide utilizationdesign (Pesticide suggestion source, attention towards labels, measurement and blending of pesticides, well-beingstrategies followed, dose, handling, and disposal of pesticide containers).

Data Analysis

The assembled information and data were appropriately coded and entered in the MS-Excel worksheet. The data was then analysed,and the results of the surveyed data were summarised into descriptive statistics.

Results and Discussion

Toxicity of dichlorvos towards *Eisenia foetida*

The effect of dichlorvos was concentration-dependent, and with increasing pesticide concentration, the percentage of survival decreased. Mortality was recorded via the paper contact method at all concentrations of the test chemical after 24 and 48 h of exposure. For 24 and 48 h, LC_{50} were 70 and 50 ppm, respectively. Within 12 h of exposure, morphological changes like constriction and swelling began to emerge from the anterior region. Earthworms showed sluggish movement with progressive signs and symptoms such as curling, coiling, and excessive oozing of mucus (Fig. 1B) at lower dichlorvos concentration (10-30 ppm). Protruding of the clitellum and expulsion of coelomic fluid brought about bleeding injuries at higher concentrations (50, 70, and 100 ppm) (Fig.1C). Mukherjee andParida, (2015), observed the same kind of toxicity in *Eudriluseugeniae* when exposed to soil spiked with lindane. However, symptoms at higher pesticide concentrations (100 ppm) coupled with starvation lead to degenerative changes starting at the center of the worm after 48 h of exposure (Fig. 1D). This form of degeneration may imply a complete drain of usable reserves of energy levels and successive autolysis of its own tissues to meet its energy necessities.

Survey of Farmers

A total of 52 farm workers were interviewed during

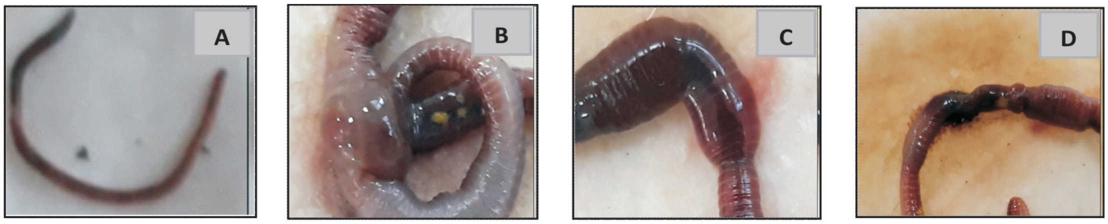

Fig. 1. Impact of 48 h of dichlorvos exposure by paper contact toxicity test on earthworm morphology. (A) Control earthworm. (B) curling, coiling and secretion of mucus at 10-30 ppm. (C) Cuticle rupture and bloody lacerations (50, and 70 ppm). (D) Clitellum bulging and degeneration at the centre of the worm (100 ppm).

the present study. After the collection of information and data through a survey, we came to know thatmost of the farmers (67.30 %) involved in the present study were 31-60 years old.Among 52 interviewed farmers, all of them apply chemical pesticides. The crops that are most frequently applied with pesticides include pulses and food grains. The pesticide using farmers mostly gave the reason that they want the protection of their crops from pests and acquire a higher harvest to earn better living and profit. The pesticide source was the agrochemical shop in the local markets of Bandarsindri and Kishangarh. They recognizepesticidesby their trade name irrespective of their chemical designation and their means of action. Pesticides were found to be stored mainly inside the house and storage rooms by the farmers. The most applied pesticides by villagers were of the organophosphate category. Some

Table 1. Respondent's knowledge regarding name, utilization, labelling, organic forming, personal hygiene, and pesticide residue entrance routes.

Question	Farmer's size	Yes (%)	No (%)	Remarks
Knowing applied pesticide type and name	52	8 (15.38)	44 (84.61)	Farmers were unaware about the pesticide type, however some of them know their names but mostly forget
Receive consultation about use, danger and other information related to pesticides	52	49 (94.23)	3 (5.76)	Mostly consult and receive information from pesticide retailors
Knowing colour coding and labelling on pesticide containers awareness program	52	16 (30.76)	36 (69.23)	Most of the farmers check seal and labelling on pesticide containers, but majority of them were unaware about the meaning of colour coding.
Participated in any workshop or	52	17 (32.69)	35 (67.30)	Mostly unaware about such things
Utilize chemical fertilizers	52	52 (100)	0.00	Easily availability and application
Knowing organic farming	52	18 (34.61)	34 (65.38)	Mostly the farmers know about the utilization of manure but not about the other organic farming methods
Bath after working with pesticides pesticide	52	40 (76.92)	12 (23.07)	
Eat/drink/smoke during pesticide spraying	52	0.00	52 (100)	As they know pesticides are harmful
Change and wash cloths after pesticide application	52	25 (48.07)	27 (51.92)	
Know pesticides are harmful	52	52 (100)	0.00	Aware
Pesticide exposure routes	Sample size	Frequency	Percentage	
Dermal	52	41	78.84	
Respiratory	52	36	69.23	
Ocular	52	7	13.46	
Oral	52	0.00	100	

of them are extremely hazardous as per the WHO-recommended classificationof organophosphates by hazard and are still used in India while restricted in other nations like Europe and the USA.The survey results have shown that males mainly apply pesticides and are most frequently applied during vegetation through simple application approaches. Other information obtained from the farmers during the survey, including their knowledge related to pesticide name, utilization, labeling, organic farming, personal hygiene, and pesticide residue entrance routes, are illustrated in Table 1.

Pesticide application

In the present study, we found that farmers apply pesticides without following the recommended dose mostly and prefer the application of multiple pesticides by blending them in a single solution. According to farmers, the utilization of cocktail pesticides provides mutual protection against pests and associated problems. Pesticide retailers, according to the respondents, mainly recommend the application of a pesticide cocktail. Yassin *et al,* (2002) revealed a comparative finding that 89.9% of total farmworkers in Gaza apply the blend of two or more than two pesticides. However, Suryawanshi and Patil, (2016) presented contradictory findings among Jalgaon farmers, where 64% of them do not apply cocktail pesticides.

During the survey, it was reported that the majority (69%) of the farmers did not follow the recommended optimum dose of pesticides during spraying (Fig.2). According to farmers, the frequent occurrence of diseases and pests leads to the ineffectiveness of existing dosage and due to the resistance of pests towards these pesticides. This trend of pesticide application at higher quantities without following recommended doses would exacerbate the negative impacts on human health as well as the entire ecosystem. It was found that farmers mostly apply pesticides upon the occurrence or before the appearance of pests and on the recommendation of agrochemical vendors. However, Yassin *et al*,(2002) reported the contradictory observation that about 56.1% of Palestine farm workers follow the recommended pesticide dose, and about 43% of them apply more than the prescribed pesticide dosage. Farmers prepare or dilute the pesticides mainly in the fields and wash the empty containers near the wells or discard them in the areas. Some farmers keep left or unused pesticides in safer places while others discard them in open fields or pour them in sewers. All farmers reported the utilization of sprayers and tractors for the application of pesticides. They reported the application of pesticide sprays mostly after every 1-3 months depending upon the crop. The empty containers are mostly utilized for storing household items, including foodstuff and water, after cleaning them. Farmers get necessary information regarding crop protection mainly from pesticide retailers' agricultural departments, company representatives, radio, TV, newspaper, and neighbor progressive farmer. However, most of them were found to get information from pesticide retailers and agricultural departments. Amid the survey, it was seen that most of the farmers were not aware of organic farming and alternative methods of pest control. Therefore, we have tried to make

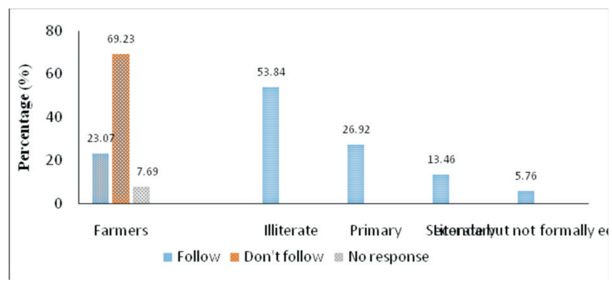

Fig. 2. Education level and percentage of farmers obeying recommending agrochemical Doses.

them aware of the alternative methods of pest management, including biological control, crop rotation, trap cropping, intercropping and utilization of naturally occurring bio-controls, organic farming, pesticide-resistant crops, and improved irrigation, fertilizing. Villagers were also found to have the desire of IPM (integrated pest management) to control pests. This means that IPM has more possibilities in the villages of Ajmer district, Rajasthan.

Education level and awareness related to agrochemicals

Education broadens the farmer's vision and plays a significant role in exposing them to different aspects and opportunities linked to farming and associated areas (Shetty *et al.,* 2010). In the present investigation, most of the farmers (53.84%) were uneducated, trailed by 26.92% of farmers having education up to primary level (Fig.2). Due to illiteracy and low education, level the consumption of pesticides may lead to misperception of farmers towards the utilization of pesticides. According to Ibitayo, (2006), little pesticide information can be ascribed to relatively low education levels. However, most of the farmers started a solid perception of the adverse effects of pesticides on the environment and human well-being. Practically, all the respondents were found to know the necessity of wearing personal protective gear (PPG). However, the majority (97%) of them do not wear overall PPG's because they think PPG's are expensive and they do not have sufficient money to buy them. The most used protective gear by the farmers is a mask (36.53%) followed by boots (25 %). The percentage of rarely used protective gearcombinations adopted by farmers is presented in Fig. 3. The current survey likewise demonstrated that most farmers realize that pesticides are harmful tohumans,creatures, and the environment;however, less percentage among them are familiar with the pesticide poisoning indications. The health effects reported by the farmers due to pesticide exposure are exhibited in Table 2. In developing countries, it has been found that exposure to pesticides is worsened due to the illiteracy of the public and lack of affordable or non-availability of protective equipment (Maumbe and Swinton, 2003).

Survey of pesticides shop employer

Pesticide sellers and retailers we surveyed in these villages have been operating fromthe last 2 to 40 years. All pesticide sellers were found to be educated, having with B.Com and Pharmacy degrees mostly and selling pesticides according to them isa profitable business. The pesticides, which were found in their shops, are purchased from agrochemical companies and government agencies of the country. Most of the retailers thought that in their shops, there are highly toxic pesticides, and they are not familiar with the pesticides banned by the government. However, organophosphates were the most prominent pesticides for the villagers in the shops. The pesticide retailers were observed to be aware of the health effects brought about by pesticides. The customers of these pesticide shops are from Mundoti, Bandarsindri, Kishangarh, and other nearby villages. The pesticide sellers advised the customers about the pesticide application when they came tobuy the pesticides in their shops. The pesticide retailers and sellers thought that leaflets and packing labels were the best ways to aware people about pesticide health effects. They also show the willingness to cooperate in the organization of awareness programs to monitor the impact of pesticides and aware of the public about the ill effects of pesticides.

Conclusion and Recommendations

The current study demonstrated that the effects of dichlorvos on *Eisenia foetida* does not only include direct toxicity but also significant morphological changes. *Eisenia foetida*showed that toxicity increased with the duration of exposure to dichlorvos.

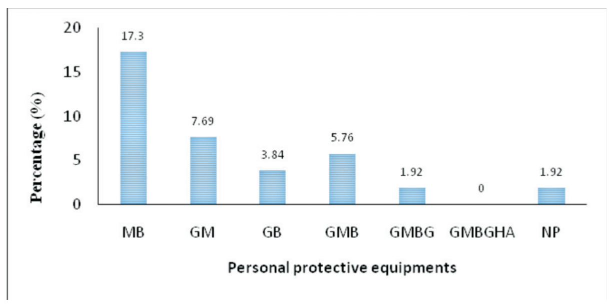

Fig.3. Farmer's percentage wearing the combinations of protective equipment's: MB (Mask + Boots); GM (Gloves + Masks); GB (Gloves + Boots); GMB (Gloves + Mask + Boots); GMBG (Gloves + Mask + Boots + Goggles); GMBGHA (Gloves + Mask + Boots + Goggles + Hat + Apron); NP (No prevention).

Table 2. Frequency of health effects reported by the farmers

Health effects	Sample size	Frequency	Percentage (%)
Headache	52	45	86.53
Dizziness	52	10	19.23
Vomiting/Nausea	52	36	69.23
Allergy	52	43	82.69
Skin/eye/nose/throat irritation	52	21	40.38
Fever	52	4	7.69
Gas formation	52	13	25
Unconscious	52	3	5.76
Coughing	52	9	17.30
No impact	52	8	15.38

This means that toxicity is related to dichlorvos accumulation in excess quantities, which proved to be detrimental to the earth worms.The survey results indicated that distinctive pesticide formulations were utilized for the security of diseases and pests of various crops in the investigation area. Lack of significant knowledge about handling, proper application, personal protection, and inappropriate disposal of empty containers among the farmers was observed. Farmers and other pesticide applicants were found to be directly exposed to pesticides, whereas other family members were found to be exposed potentially. The pesticide exposure symptoms identification among some farmers was lower due to the lack of awareness regarding pesticide hazards. Amid the present study, it was seen that pesticide exposure happens mainly due to the lack of awareness about the safe usage of pesticides because most of the field workers were uneducated in rural areas.Pesticide safety awareness and cost-benefit assessment can be the key pesticide policy in the future. Education and training can prove a prominent role in understanding the negative impacts of indiscriminate pesticide utilization. Education and training related to pesticide well-being should utilize a straightforward program that engages illiterate farmers more successfully. Pesticide labels should be in local languages, with clear colour codes and symbols that will prove the information to many illiterate farmers. Therefore, the authors strongly endorse an extensive awareness scheme for the safe use of pesticides.We are quite hopeful that the awareness related to a pesticide will surely lead to better health and the environment of the villages, and it would be possible to change the villager's practices from conventional to sustainable agriculture.

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