



Asian Journal of Epidemiology

ISSN 1992-1462

science
alert
<http://www.scialert.net>

ANSI*net*
an open access publisher
<http://ansinet.com>

An Epidemiological Study on the Health Effects of Endosulfan Spraying on Cashew Plantations in Kasaragod District, Kerala, India

¹Asha Embrandiri, ²Rajeev P. Singh, ¹Hakimi M. Ibrahim and ³Anisa B. Khan

¹School of Industrial Technology, Universiti Sains Malaysia, 11800, Pulau Pinang, Malaysia

²Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi, 221005, India

³Pondicherry University, Kalapet, Puducherry, India

Corresponding Author: Asha Embrandiri, School of Industrial Technology, Universiti Sains Malaysia, 11800, Pulau Pinang, Malaysia Tel: + 604-6532217 Fax: + 604-6573678

ABSTRACT

The study involved investigations of prevalence rates of health problems of residents in some affected regions of Kasaragod district, Kerala, India seven years after the official banning of the use of Endosulfan by the Plantation Corporation of Kerala (PCK) on their Cashew plantations. Thousand respondents were selected using simple random survey. It was observed that 0-30 year age group had recorded the highest cases of mental retardation with 74.5% male and 74.1% female. Also in the 0-14 years age group 46% males and 42.5% females had Congenital anomalies whereas in the 15-30 years age group 30.4% males and 31.7% female cases were recorded. As with the case of cancer, only 39.2% had mostly lung, throat or prostate cancers, whereas, 35.4% females had breast, ovarian or blood cancer. In the 0-14 years age group there were only 2 male and 3 female having cancer. Generally the prevalence of disease was highest in Males in Enmakaje Panchayat (0.31 for 0-14 years) but lowest in Muliya and Periya (0.1) above the age of 46 years. Whereas, in females, it was highest among 15-30 years age group in Cheemeni (0.38) and also lowest (0.11) for women over age 46 years. Although, it had been several years after the ban on the use of Endosulfan in the plantation and residues are no more present, there is still a likelihood of the children being born with deformities similar to the effects of pesticide poisoning.

Key words: Endosulfan, prevalence, morbidity, mental retardation, congenital abnormalities

INTRODUCTION

Pesticides are considered a vital component of modern farming, however, concerns about human health and environmental effects of pesticides have increased over the past decade (Van-der-Werf, 1996; Wilson and Tisdell, 2001). From the Fig. 1 it is clear that organochlorines are still the most commonly used pesticides in India. Negligence during handling of pesticides usually as part of the operator error, lack of information or lack of training can cause a serious health risk for farmers who are the major pesticide users and are regularly exposed to pesticides in many ways (Koh and Jeyaratnam, 1996; Reeves and Schafer, 2003). A number of studies have been carried out on farmers with the goal of determining the health effects of pesticide exposure (Kishi, 2002; Damalas *et al.*, 2006). The World Health Organization (WHO) and the United Nations Environment Programme (UNEP) estimate that each year, 3 million workers in agriculture in the developing world experience severe poisoning from pesticides, about 18,000 of whom die (Miller, 2004).

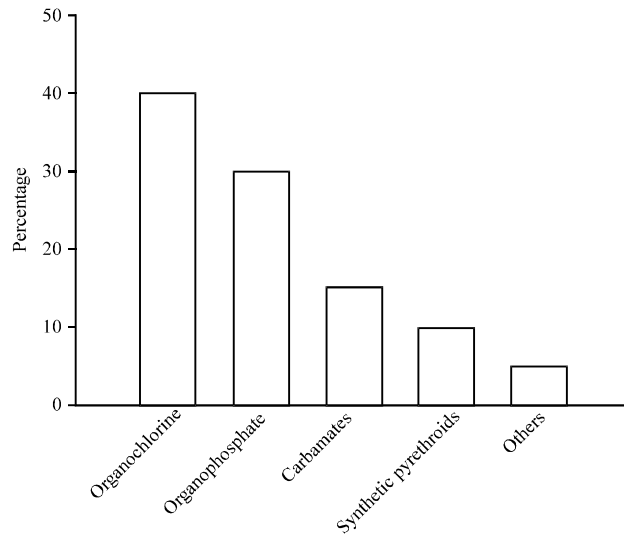


Fig. 1: Usage of different pesticides in India

According to researchers from the National Institutes of Health (NIH), licensed pesticide applicators that used chlorinated pesticides on more than 100 days in their lifetime were at greater risk of diabetes (Raj, 2010). Endosulfan an organo-chlorine is a kind of pesticide which gained recognition in the late 50's and its use became widespread as an alternative to organophosphorus as a less harmful pesticide. It is primarily used to kill insects and mites on crops including tea, coffee, cotton, fruits, vegetables, rice and grains. From the results of LD50 tests, which document the amount of a chemical required to kill 50% of a population of laboratory rats, pesticide safety is classified by the World Health Organisation (WHO). Under this system, endosulfan is currently classified as Class II-moderately hazardous to human health. However, the United States Environmental Protection Agency (EPA) rates endosulfan as Category Ib-highly hazardous. Endosulfan had been banned by many countries due to the pressures of various environmental bodies and results of the incidences that have occurred but it is still being used and sold in many of the third world countries today such as India because they are one of the largest producers (41033 MT between 1995 and 2000) (NIOH, 2002). Endosulfan is readily absorbed by the stomach, the lungs, and through the skin, meaning that all routes of exposure can pose a hazard.

Although, the short-term toxicity of Endosulfan is of immediate concern, there are also long-term effects to consider. There is some indication that Endosulfan can have adverse effects on the immune system at low levels of exposure (ATSDR, 1993). Another concern, especially in developing countries, is that people with low protein diets may be more sensitive to the effects of this pesticide (ATSDR, 1993).

The short and long term health implications of the use of Endosulfan as a pesticide was the origin of the incidence in Kasaragod district, Kerala, India. People of 15 villages (over half a million people) were subjected to continuous exposure to Endosulfan aerially sprayed three times a year by the Plantation Corporation of Kerala (PCK) for over 2 decades. This was a measure to control tea mosquitoes that attacked the cashew fruits on their plantations. Cashew (*Anacardium occidentale*) belongs to the family Anacardiaceae. It is widely grown in tropical

climates for its nuts and cashew apples. It is one of the cash crops of the state and the PCK owns several cashew plantations spread across the state.

Congenital Birth defects, reproductive health problems, cancers, loss of immunity, neurological and mental diseases were reported among the villagers residing in and around the plantation areas (Usha and Harikrishnan, 2005). People of the area had begun to complain then health based scientific studies conducted by National Institute of Occupational Health (NIOH) and Centre for Science and Education (CSE), India confirmed that the health problems were directly linked to the exposure to the Endosulfan spraying by PCK. Thus aerial spraying was stopped officially in 2003 and in 2006 a permanent ban was imposed by the Government of Kerala.

This study was aimed at finding out the current prevalent rates of common health problems associated to Endosulfan exposure not to the applicants but also to the people residing in the areas close to the cashew plantations.

MATERIALS AND METHODS

The survey was conducted from the month of December 2008 to March 2009 in 5 panchayats (elective village council) surrounding three of the Plantation Corporation of Kerala (PCK) cashew farms in Kasaragod District of North Kerala, India namely; Enmakaje, Kumbadaje, Cheemeni, Pullur-periya and Muliya. Figure 2 shows the map of Kasaragod showing the PCK plantation area and surrounding affected area

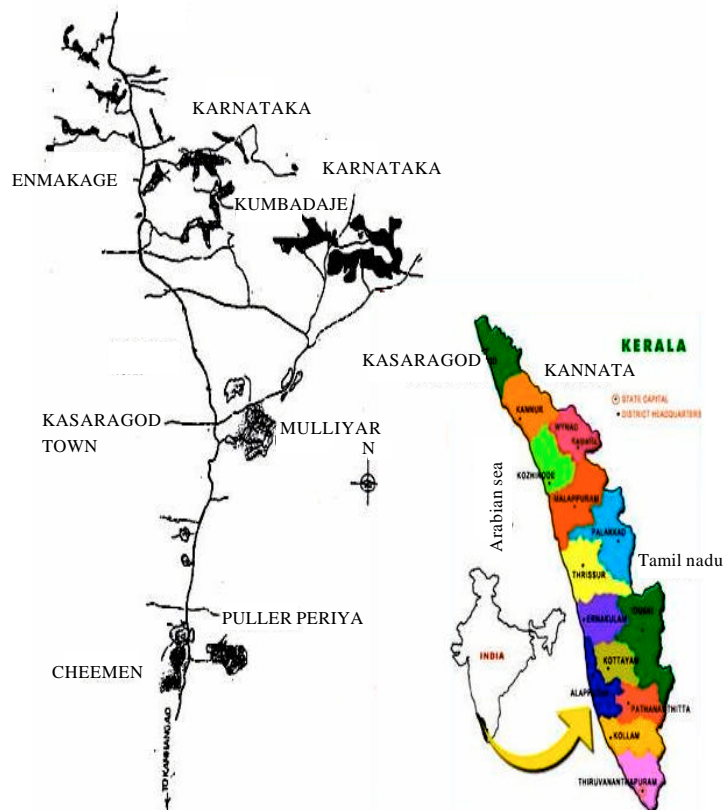


Fig. 2: Map of Kasaragod District, Kerala, India showing the PCK plantation area and surrounding affected area

and surrounding affected areas. Random method of survey was used to select the households. Information pertaining to their duration of residence in the area, diagnosis of disease or any health problems and other socio-demographic data was obtained using closed ended questionnaires. Data was also collected from the Primary Healthcare Centres (PHC) and District Medical offices.

There were a total of a 1000 respondents which included men, women and children of different age categories including the records obtained from the health centres and people who were not willing to disclose their health status but provided us other information. It was mainly an informal method of questioning because residents had become hostile to strangers due to the numerous reporters and researchers who had come during the time of the major news flash, invaded their privacy and promising things that never happened. The data was collected and analysed using Microsoft Excel package and presented as tables and charts showing the prevalence rates of health problems. Prevalence is the number of cases of a specific disease present in a given population at a certain time. With regards to this survey, the point prevalence was studied during the three months period whereby the data was collected from the people present at that time.

RESULTS AND DISCUSSION

Among the 1000 respondents out of the 5 different panchayats, 104 males were between the ages of 0-14 and 166 females, in that same age category. In the 15-30 year age group there were 109 males and 210 females. One hundred and thirty nine males and hundred females fall under the 31 to 45 group, while 95 men and 77 women were above 46 years of age (Table 1). Seventeen percent of the male respondents have lived there for less than 5 years and 18% females probably because they are newly married and have just shifted to this region (Table 2). Similarly, 21% males (92) and 18.4% (102) females have been there for between 5 and 10 years. It can be observed, that the highest male population 182 (40%) have lived in the area for over 20 years, whereas for the women 38% of them have lived there for 10 to 20 years.

An over view of the data shows that the most affected group of people with Mental Retardation and Congenital anomalies/physical handicap were between the ages of 0-30 years irrespective of gender. This may be because their parents might have been exposed to prolonged aerial spraying and thus had children born with such problems. The older ones in their 20's might have been subjected to the direct effects of spraying. 40.4% females and 39.8% males between 15-30 year age group have mental retardation (Table 3).

Table 1: Demographic profile of the respondents

Age (years)	Male	Female	Total
0-14	104	166	270
15-30	109	210	319
31-45	139	100	239
>46	95	77	172

Table 2: Residential history of the respondents

Duration (years)	% Male	% Female
< 5	17.0	18.0
5-10	21.0	18.4
10-20	22.0	38.0
>20	40.0	25.6

In the 0-14 years age group 46% males were born with some form of handicap or birth defect and females with 42.5% (Fig. 3). For skin related problems (Fig. 4), there was an even distribution in the number of people affected; percentages of the affected range between 12.9% (5 males) in the 46 years and above category and 34.5% (10 females). This could mean that all age groups are susceptible to this problem from a new born to an aged male or female. Among the other noticeable health problems in the 5 panchayats, infertility was another pertinent case which was also common to both the genders (Fig. 5) however, it was not possible to tell about any child below 14 years since they had not attained sexual maturity hence no cases. Between the ages of 15-45 years we have the most cases of female problems such as disruption of menstrual cycles, stoppage, irregular or excess and other gynecological problems (foetus death), whereas for the males (Saiyed *et al.*, 2003) had reported on the cases of low sperm count and changes in morphology of sperm.

Table 3: Mental retardation and psychiatric cases of the different age groups

Age groups (years)	% Male	% Female
0-14	34.7	33.7
15-30	39.8	40.4
31-45	15.3	21.3
>46	10.2	4.6

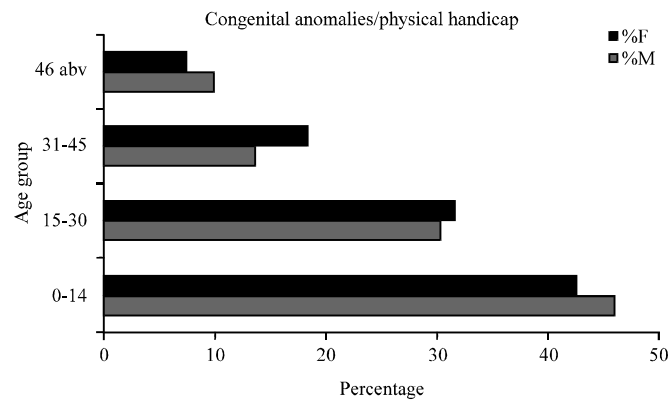


Fig. 3: A bar-graph representing people having forms of birth defects

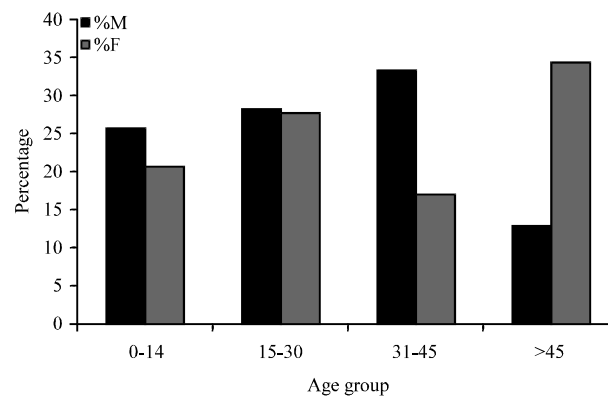


Fig. 4: Chart showing the different age groups with skin problems

In general, the prevalence of disease in males is highest in enmakaje panchayat (0.31 at 0-14 years) but lowest in Muliyar and Periya (0.10) above the age of 46 years (Table 4). Whereas, in females, it is highest among 15-30 years age group in Cheemeni (0.38) but again lowest in Cheemeni (0.11) for women over age 46 years. Looking at the percentage of prevalence by the different health problems (Table 5); males between 0-14 years and females in the 15-30 age group with respiratory problems had the lowest prevalence ratio of 0.010 whereas mental retardation in the 15-30 age group recorded the highest prevalence for males (0.358).

Most of the records of Endosulfan application or spraying around the world had led to acute toxicity and instant death of humans or animals as a result of exposure to contaminated food or water bodies running by the plantations. Endosulfan has been reported to

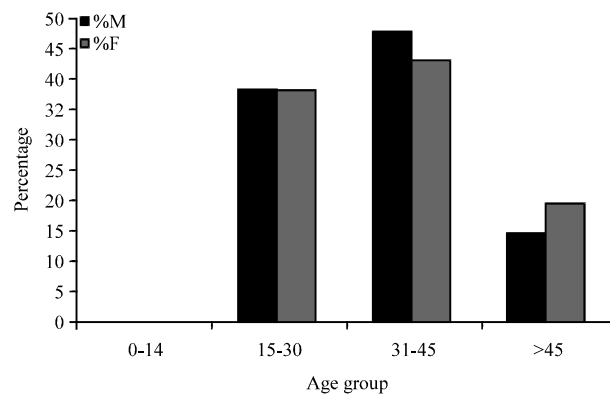


Fig. 5: Chart showing the Infertility cases among the surveyed population

Table 4: Prevalence rates in the affected areas.

Panchayats	Age group (Years)	Male	Female
Chemeeni	0-14	0.21	0.15
	15-30	0.23	0.38
	31-45	0.22	0.17
	>46	0.18	0.11
Periya	0-14	0.21	0.18
	15-30	0.23	0.20
	31-45	0.14	0.15
	>46	0.10	0.13
Kumbadaje	0-14	0.29	0.25
	15-30	0.26	0.33
	31-45	0.20	0.27
	>46	0.20	0.16
Enmakaje	0-14	0.31	0.23
	15-30	0.29	0.22
	31-45	0.26	0.16
	>46	0.13	0.17
Muliyar	0-14	0.20	0.25
	15-30	0.30	0.17
	31-45	0.19	0.22
	>46	0.10	0.14

Table 5: Prevalence rates of the different health problems

Health problems	Age group (Years)	Male	Female
Mental retardation	0-14	0.327	0.181
	15-30	0.358	0.171
	31-45	0.108	0.190
	>46	0.105	0.052
Epilepsy	0-14	0.164	0.115
	15-30	0.110	0.076
	31-45	0.058	0.070
	>46	0.053	0.039
Congenital anomalies	0-14	0.452	0.307
	15-30	0.284	0.181
	31-45	0.101	0.220
	>46	0.105	0.117
Cancer	0-14	0.029	0.012
	15-30	0.046	0.043
	31-45	0.065	0.110
	>46	0.116	0.156
Skin problems	0-14	0.096	0.036
	15-30	0.101	0.038
	31-45	0.094	0.050
	>46	0.053	0.130
Infertility	0-14	0.000	0.000
	15-30	0.073	0.038
	31-45	0.072	0.090
	>46	0.032	0.052
Respiratory	0-14	0.010	0.024
	15-30	0.064	0.010
	31-45	0.058	0.030
	> 46	0.084	0.078
Eye/ear	0-14	0.192	0.084
	15-30	0.128	0.052
	31-45	0.072	0.060
	>46	0.042	0.104

be highly toxic and can be fatal if inhaled, swallowed or absorbed through the skin. Acute oral toxicity is reported to be higher than dermal toxicity (Sang and Petrovic, 1999). A number of acute poisoning cases have been reported due to Endosulfan. Ingestion or breathing high levels of endosulfan may lead to convulsion and death. Endosulfan directly affects the central nervous system (Anon, 1996, 2001) and recurrent epileptic seizures are also reported (Kutluhan *et al.*, 2003). It has been reported that persons having protein deficient diet also possess high risk (Anon, 1996; Sang and Petrovic, 1999).

Endosulfan ingestion is known to affect the kidneys and liver (Vengateshwarlu *et al.*, 2000). It inhibits leukocytes and macrophage migration (this is the inhibition of the natural immune system by disrupting anti-body protection) causing adverse effects on humoral and cell-mediated immune system (Sang and Petrovic, 1999). It is also a potential tumor promoter (Fransson-Steen *et al.*, 1992). In Cuba, Endosulfan Poisoning was responsible for the deaths of 15 people in the Western province of Matanzas, in February 1999. A total of 63 people became ill

after consuming food contaminated with Endosulfan (Mccauley *et al.*, 2006). Similarly, in the Borgou province in Benin, West Africa, Endosulfan poisoning caused many deaths during 1999-2000 cotton season. Official records state that at least 37 deaths occurred and 36 were taken seriously ill. A boy had died after eating corn contaminated with Endosulfan (Ton *et al.*, 2000). Endosulfan caused a rise in death numbers due to poisoning in Srilanka from 1994 to 1998 (Roberts *et al.*, 2003).

Here, in the Kasaragod tragedy, the total cases of death were not recorded because the magnitude of the problems had not been fully established and people were afraid of opening up because of the stigma it had created. Children were sent out of school due to sudden formation of rashes on their skin, many deformed babies were hidden, and girls with menstrual problems could not be married off. etc. Only after the Government had taken the problem seriously that some scientific bodies were sent to carry out tests and surveys and some form of data was published. This survey reports on the prevalence of health problems in the selected areas as a follow up study and is solely based on the information given by the respondents, health care workers and local doctors. The households were however chosen completely at random and could said to be representative of the average affected person in these areas. The water samples in these areas were also analyzed for the presence of heavy metals but came out negative because Endosulfan has a short life span (50 days) and does not remain in the soil, water or environment beyond its half life.

Previous studies by NIOH (2002) in Padre village reported that 1.10% prevalence rates of epilepsy in males and 1.94% in females also there were 0.83% males with physical abnormalities and 1.94% of females. However, this represents only a small fraction of the entire affected areas as compared to the 5 panchayats in this study. A high prevalence of infertility in females was recorded (39.1% in the 10-15 age group and 83% in females above the age of 16) whereas in the present study there was a decrease as 12.9% prevalence was recorded the 15- 45 age group. From Usha and Harikrishnan (2005); Cancer deaths recorded in Enmakaje Panchayat alone had increased from 37 (1982-1987) to 49(1988-1993). It was 71 deaths from 1994-99. This means an increase of 33% in just 6 years and 92% in 12 years. The current cases of cancer are 11.58% prevalence in males above the age of 46 and 15.6% in females among the 1000 respondents. NIOH data stated that prevalence of 0.83% male and 1.94% female with congenital anomalies. This in comparison to our data (45.2% males and 30.7% females in the 0-14 age bracket) could only mean that it had not manifested as at that time.

It can be concluded that after the ban on Endosulfan spraying in the Plantation Corporation of Kerala (PCK) in 2006, by the Government of Kerala, the normalcy in the environment had returned according to local bee keepers as the insects, butterflies, bees, frogs, fishes etc had come back. But this is yet to be said about the state of human lives in these areas. In a total of 39 Panchayats in Kasaragod district, 11 were declared as Endosulfan affected and my study sites; Cheemeni, Pullur-Periya, Kumbadaje, Enmakaje, Muliya recorded some of the highest cases of Mental Retardation, Epilepsy, Congenital Anomalies and other Physical Handicap.

CONCLUSION AND RECOMMENDATIONS

Results of this study showed that the prevalence rates of health problems in general had noticeably come down as low as 0.38 for females between the 15-30 year age group in Cheemeni which was not the case as at the time of the previous reports and surveys (Usha and Harikrishnan, 2005; NIOH, 2002) which showed direct link between the spraying and the various health problems noted earlier and rates were alarming. This can be attributed to the fact that Endosulfan

has a short lifespan and does not remain in the environment for long. Although, Endosulfan residues are no more present in the food, water, or air in these areas, there is still chances that the offspring of the affected people could manifest some of these symptoms as a result of DNA mutations. They will probably live with the “fear” for the rest of their lives not knowing what will happen.

Pesticide use has become a major factor in the agricultural sector today, it is therefore recommended to make more awareness about the dangers of pesticide use and emphasis laid on use of protective gear if and when applied. The nearby villagers should be informed of the time of spraying and necessary precautions to be taken during the time of spraying. Agricultural Organizations and Scientific Research bodies should carry out more detailed studies in the affected area of Kasaragod District as not much scientific documentations were published on this issue. The Government should promote and encourage more organic farming practices and integrated pest management systems on their own plantations.

ACKNOWLEDGMENT

Authors would like to acknowledge the assistance of the Primary Healthcare centers and residents in these areas who helped in collecting information and providing necessary assistance and Dr (Mrs.) Anisa B. Khan, Department of Ecology and Environmental Sciences, Pondicherry University, India, who supported throughout the tenure of this project.

REFERENCES

- ATSDR, 1993. Toxicological profile for endosulfan. United States Agency for Toxic Substances and Disease Registry, Atlanta, GA. Available from NTIS, Springfield, VA.
- Anon, 1996. Pesticide information Profile- Endosulfan EXTNET- Extention Toxicology Network.
- Anon, 2001. Endosulfan Fact sheet (ToxFAQs) Agency for Toxic Substances and Disease Registry (ATSDR). US Dept of Health and Human Services, Public Health Services, Division of Toxicology, Atlanta Georgia.
- Damalas, C.A., E.B. Georgiou and M.G. Theodorou, 2006. Pesticide use and safety practices among Greek tobacco farmers: A survey. *Int. J. Environ. Health Res.*, 16: 339-348.
- Fransson-Steen, R., S. Flodstrom and L. Warngard, 1992. The insecticide endosulfan and its two stereoisomers promote the growth of altered hepatic foci in rats. *Carcinogenesis*, 13: 2299-2303.
- Kishi, M., 2002. Farmer's perceptions of pesticides and resultant health problems from exposures. *Int. J. Occup. Environ. Health*, 8: 175-181.
- Koh, D. and J. Jeyaratnam, 1996. Pesticides hazards in developing countries. *Sci. Total Environ.*, 188: S78-S85.
- Kutluhan, S., G. Akhan, F. Gulterkin and E. Kurdoglu, 2003. Three cases of recurrent epileptic seizures caused by endosulfan. *Neurol. India*, 51: 102-103.
- Mccauley, L.A., W.K. Anger, M. Keifer, R. Langley, M.G. Robson and D. Rohlman, 2006. Studying health outcomes in farm-worker populations exposed to pesticides. *Environ. Health Perspect*, 114: 953-960.
- Miller, G.T., 2004. *Sustaining the Earth*. Chap. 9, 6th Edn., Thompson Learning Inc., Pacific Grove, CA, pp: 211-216.
- NIOH, 2002. The Investigation of Unusual Illnesses Allegedly Produced by Endosulfan Exposure in Padre Village of Kasargod District (N. Kerala). National Institute of Occupational Health, Ahmedabad, India

- Raj, M.A.A., 2010. Study on the Environmental Pollution Control of Some Pesticides and Insecticides in Soil by Using Bacteriae. Bharath University, September 15, 2009. <http://shodhganga.inflibnet.ac.in/handle/10603/42>.
- Reeves, M. and K.S. Schafer, 2003. Greater risks, fewer rights: US farmworkers and pesticides. *Int. J. Occup. Environ. Health*, 9: 30-39.
- Roberts, D.M., A. Karunarathna, N.A. Buckley, G. Manuweera, M.H. Sheriff and M. Eddleston, 2003. Influence of pesticide regulation on acute poisoning deaths in Sri Lanka. *Bull. World Health Organ.*, 81: 789-798.
- Sang, S. and S. Petrovic, 1999. Endosulfan- A Review of its Toxicity and its Effects on the Endocrine System WWF. World Wild Life Fund, Canada.
- Ton, P., T. Silvere and S. Vodouhe, 2000. Endosulfan deaths and poisonings in Benin. *Pesticide News No. 47*. The Journal of Pesticide Action Network, UK
- Usha, S. and V.R. Harikrishnan, 2005. Endosulphan: Fact sheet and answers to common questions. Arsha Printers, IPEN Pesticide Working Group Secretariat, Thiruvananthapuram, India.
- Van-der-Werf, H.M.G., 1996. Assessing the impact of pesticides on the environment. *Agri. Ecosyst. Environ.*, 60: 81-96.
- Vengateshwarlu, K., K. Suryarao, V. Srinivas, K. Sivaprakash, N.R. Jagannadharao and A. Mythilai, 2000. Endosulfan poisoning- a clinical profile. *J. Assoc. Physicians India*, 48: 323-325.
- Wilson, C. and C. Tisdell, 2001. Why farmers continue to use pesticides despite environmental, health and sustainability costs. *Ecol. Econ.*, 39: 449-462.