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Original Research Article

Determinants of pesticide exposure among workers in floriculture industry in rural Maharashtra

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ABSTRACT

Background: Pesticides are extensively used in floriculture where workers are mostly unskilled and may not have appropriate knowledge about safety. Acute accidents during spraying are reported, chronic exposure goes unnoticed. There are not many Indian studies regarding health risks and safety practices among floriculture workers in India. Hence this study to assess pesticide exposure, to find their determinants and suggest appropriate preventive measures.
Methods: Study was cross sectional in Floriculture Park, Talegaon (D), Pune, Maharashtra, India using cluster sampling from February 2018 to July 2019. Prevalence of morbidities being 63% sample size was calculated as 111 (allowable error 15%). Socio-demographic, work and health related variables were recorded using a pretested structured questionnaire. Clinical examination and laboratory investigations were done by medical experts.
Results: A total of 118 workers participated. Only half (51.2%) were using personal protective devices. None were following reentry guidelines. 13.3% males and 4.1% females had low serum cholinesterase level which is a biomarker of pesticide exposure. Sprayers had significantly high risk of low serum cholinesterase levels (OR=3.31) as compared to others. With exposed subjects which included both sprayers as well as polyhouse workers the association increased with OR=4.27. However association was not significant when working in polyhouse alone was considered as a risk factor (OR=1.256).
Conclusions: Presence of exposure was the only factor that had a statistically significant association with low Serum Cholinesterase levels. Safe occupational practices like use of personal protective devices, rotation of exposed workers, monitoring of serum cholinesterase levels and health education of workers should be undertaken.

Keywords: Floriculture, Pesticide exposure, Serum cholinesterase

INTRODUCTION

Pesticides are extensively used in agriculture to prevent as well as to control pests and weeds. Use of chemical pesticides is much more common than biopesticides; more so in non-edible ornamental crops. World over the use of chemical pesticides has been increasing to enhance production and improve quality and to increase profits. India too has seen a tremendous rise in use of chemical pesticides from 46,620 M.T. (Tech. grade, 2010-2011) to 1,72,531 M.T. (Tech. grade, 2016-2017) even though the area of cultivation has reduced from125 million hectares in 2010-2011 to 96 million hectares in 2016-2017.[1] Pesticide consumption in Maharashtra is 0.57 kg per hectare as compared to the national average of 0.29 kg per hectare in 2016-2017.[2]

Pesticides are also extensively used in floriculture as outer appearance of flowers holds the key in market. Workers in this industry are mostly unskilled agricultural labourers who may not have appropriate knowledge and safety concerns. Pesticides can be broadly classified into

organochlorines, organophosphorus and carbamates; all of which have potential adverse effects in humans. Though W.H.O has classified and labeled pesticides as class 1, 2, 3 and 4 based on their toxicity, toxic and substandard or wrongly labeled pesticides may find their way in the market. Commonly used pesticides in Floriculture are Rogor, Movento, Imidacloprid, Acephate, Buprofenzin, Emactin benzoate and Nuvan (mostly WHO class 1 and 2). While acute accidents that occur during spraying are reported, as was the case of deaths of cotton farmers of Yavatmal district of Maharashtra in 2017; chronic exposure goes unnoticed.[3] When pesticides are used in enclosed spaces of a polyhouse not only the sprayers but also other workers are at risk of exposure due to residue. The risk is higher when there is no awareness and no enforcement of use of personal protective devices, proper labeling, handling and storing of pesticides and following the guidelines for re-entry period. This can lead to various health hazards like allergic reactions, dermatitis, pneumonitis, cancers, neuropathies, endocrinal effects and reduced cholinesterase levels leading to cholinergic symptom.[4]

Pesticides are crucial in improving agricultural productivity. But they are also an occupational health hazard for agricultural workers. There are very few Indian studies addressing this concern in workers of the upcoming floriculture industry. Hence this study was undertaken to assess pesticide exposure among workers in floriculture and to find their determinants so as to suggest appropriate preventive measures.

Aims and objectives

To assess determinants of pesticide exposure among workers in floriculture industry in rural Maharashtra.

METHODS

Study design was cross sectional. It was undertaken in randomly selected floriculture units specialized in growing cut flowers at Floriculture Park at Talegaon Dabhade M.I.D.C, Pune, India .Study period was from February 2018 to July 2019. Prevalence of morbidities in workers in floriculture industry is reported to be 63%.[4,5] Thus the estimated sample size was 111. The sampling type was cluster sampling. Total number of floriculture farms in the study area is 100. There are approximately 20 to 25 workers on each of these farms. As the sample size was 111, 6 farms were selected randomly from these 100 farms. Inclusion criteria was all the workers present and who agreed to participate in the study from the selected farms Exclusion criteria was those who are not involved in cultivation practices such as administrators. Approval from the Institutional Ethics Committee and written permission from the farm owners was obtained. The purpose of the study and confidentiality was explained to all the study subjects and written informed consent taken.

A pretested structured questionnaire was used to collect data related to socio-demographic, work and health related variables. Clinical examination was done by medical experts. Venous blood (5 ml) was collected by experts from those who gave consent. Haemoglobin estimation was done by Sahli's and serum cholinesterase levels by Butirylthio choline method. Data collection was supervised for completeness, accuracy and clarity. Consistency of data entry was checked by reentering 10% data. Data was analysed using SPSSversion19.

Medical advice and Health education related to prevention of occupational morbidities was given immediately to the workers after data collection.

RESULTS

A total of 118 workers participated in the study of which 63 (53.38%) were males and 55 (46.61%) females. Age of the study population ranged between 15 to 75 yrs, average being 32 yrs. Majority of the study population was uneducated [42 (35.59%)] or educated upto primary level only [45 (38.1%)].

104 (88.13%) of the study population were unskilled agricultural workers and doing single or multiple activities related to floriculture at the farm such as spraying, packing, irrigation or working in polyhouse. Majority [62 (52.54%)] of the workers were involved in working in polyhouse. It was noted that workers were involved in more than one activity. For example a person who was working in polyhouse was also involved in spraying and irrigation.

Mean duration of employment was 4.5 years with 9 hours daily for 6 days in a week. The proportion of workers with more than three years' experience was almost half [58 (49.15%)] of the study participants.

Workers who are mostly exposed to pesticides in a floriculture industry include sprayers, polyhouse workers and production supervisors. They are expected to follow certain protective practices. Practices regarding safety of the study sample are described in Table 1.

Table 1: Practices regarding personal protection.

Practices	N (%)
Change of clothes after work	77 (63.6)
Use of gloves/masks	62 (51.2)
Not eating/breast feeding in polyhouse	98 (81.1)
Do not use empty containers for storage of food	108 (89.3)
Following restriction about re-entry period	0 (0)

Though majority had appropriate practices regarding personal protection It was observed that only about half (51.2%) were using personal protective devices like

gloves and masks. Further, almost 37% workers did not take bath and change work clothes after work hours. It is advised that a worker should not enter a polyhouse within 4 to 12 hours of spraying of pesticide as per the class of chemicals. However it was noted that none were following this guideline and were arbitrarily following a gap of 20 to 30 minutes.

Clinical history was taken for frequent ailments and is summarized in Table 2.

Table 2: Frequency of major morbidities.

Morbidity	N (%)
Cuts and wounds	41 (33.9)
Breathing difficulty	22 (18.2)
URI/LRI	57 (47.1)
Skin and ENT	42 (34.7)
Central nervous system	66 (54.5)
Musculoskeletal	75 (62)
Chronic illness	3 (2.5)
Any of the above	106 (87.6)

Most of the people (106/118) gave history of some ailment. Most common was musculoskeletal problems, followed by problems related to central nervous system (CNS). These problems included headache, tremors and sleepiness.

Out of 118 people only 109 allowed drawing blood for laboratory investigations. Table 3 shows distribution of haemoglobin with respect to gender.

Table 3: Distribution of haemoglobin with respect to gender.

Haemoglobin (g/dl)	Female	Male
	N (%)	N (%)
<12	43 (87.8)	27 (45)
12-14	5 (10.2)	24 (40)
>14	1 (2.0)	9 (15)
Total	49	60

It was observed that maximum workers which included 87.8% women and 95% men were anaemic. More alarmingly 45% male workers had haemoglobin <12 g/dl.

Serum cholinesterase level acts as a biomarker for exposure to organophosphorus pesticides. Activities carried out by floriculture workers which have potential for exposure are storing, mixing, application of pesticides (done by sprayers); working in sprayed fields (polyhouse workers). Those involved in packing or irrigation are at lesser risk of exposure. Levels less than 3800 U/l is considered low for women and less than 4550 U/l is considered low for men.108 workers from our study population gave consent for this test. Table 4 shows distribution of serum cholinesterase levels with respect to gender.

Table 4: Distribution of serum cholinesterase with respect to gender.

Serum cholinesterase (U/l)	Female	Male	Total
<3800	2	4	6
3800-4000	0	1	1
4000-5000	7	3	10
>5000	39	52	91
Total	48	60	108

It was observed that percentage of male workers with low serum cholinesterase levels was thrice (13.3%) as compared to females (4.1%). This may be because none of the female workers are involved in high exposure activity of spraying.

In order to assess the risk of exposure, serum cholinesterase level less than 4000 U/l was considered as low and above it was considered as normal. These levels were further viewed with respect to all risk factors (Table 5).

Table 5: Cholinesterase level and risk factors.

	Cholinesterase level			
Risk factor	Low	Normal	Total	OR
Sprayers	2	9	11	3.31
Polyhouse workers	2	28	30	1.26
Exposed	6	59	65	4.27
Do not change clothes	2	34	36	0.79
Do not use gloves	3	46	49	0.90
Eat inside polyhouse	1	16	17	0.83
Central nervous system	4	59	63	0.95

It was noted that spraying of pesticide had significantly high risk of low serum cholinesterase levels (OR=3.31) as compared to others. When the study population was divided as exposed and not exposed the exposed subjects which included both sprayers as well as polyhouse workers the association increased with OR=4.27. However association was not significant when working in polyhouse alone was considered as a risk factor (OR=1.256).

DISCUSSION

The occupational morbidity found in workers due to exposure to pesticides is multifactorial and not simply the effect of direct contact. Among these are socioeconomic conditions, education, type of work activity, length of exposure, practices regarding personal protective devices, individual susceptibility and nutritional state of the worker.[6] Majority of workforce in the present study was unskilled agricultural labour from low socioeconomic class and with low levels of education Almost half of our

study population had 3 or more years of exposure to pesticides in floriculture farms. Practices regarding personal protection were sub optimal .This could be the reason for high prevalence of occupational morbidity in our study. However there was no statistically significant association of these three factors with low cholinesterase levels - the biomarker of pesticide toxicity. A study in Tanzania by Mrema et al reported that women with low levels of education, safety awareness and training in proper use of pesticides may be at high risk of pesticide exposure and its resultant adverse effects.[7] Our study found four times higher odds of low cholinesterase not only in certain types of work like spraying but also working in polyhouse. But irrespective of whether the occupation involves the use of pesticides, the presence of such chemicals in the working environment constitutes potential occupational exposure.[8] Many among the study population [55 (46.6%)] reported doing all types of work activity. Multitasking increased the number of workers exposed to pesticides and their odds of being affected. The fact that the workers were staying in the farms put the children and non-working members also at risk. Rotation of sprayers and avoiding multitasking can help to reduce exposure.

Protective devices play a major role in preventing exposure to pesticides. Pathak et al reported that the risk of cholinesterase inhibition and symptoms is greater in tractor-mounted than in knapsack pesticide sprayers and in both groups compared to controls.[9] In a survey of smallholder knapsack operators in 24 different countries; users who felt that their use of personal protective equipment while spraying was best practice were 0.60 (95% CI 0.44–0.84) times less likely to experience health incident.[5] Despite this use of appropriate protective devices is less common especially in developing countries like India. A cross sectional study in Bangalore by Maria et al reported that only 7.8% of people wear indigenously modified personal protective equipment (PPE) while working in floriculture industry.[10] Though the use of protective devices in the present study was more as compared to above study, the inappropriate personal protective practices can be risk factor for overall occupational morbidities being seen in 106 (89.83%) and CNS morbidities in 66 (54.5%) workers in our study area. Further 13% of male workers and 4.5% of female workers had low serum cholinesterase levels. This is in concurrence with a study in rural Japan by Nagami et al, reported that the organophosphate metabolite level in the urine of the males was higher than that of the females.[11] This is because female workers are not involved in spraying. However females were exposed to residual pesticides while working in the polyhouse. A California study reported 4.8% of the study population had cholinesterase values at or below the California threshold values for removal from continued exposure to cholinesterase-inhibiting pesticides.[12] This is less as compared to our study where 6.4% had low cholinesterase levels.

The alarming finding of anaemia in 45% of male workers also draws attention to exposure as organophosphorus compounds are known to affect haemoglobin levels. In a study by Rastogi et al, in mango plantation of Malihabad (Lucknow, U.P.) results indicated significant decrease in the mean value of hemoglobin in the exposed group compared to that observed in the control group possibly as a result of the decreased size of red blood cells or impairment of biosynthesis of heme in bone marrow.[13] Another possible interpretation is binding of organophosphorus insecticides to iron, followed by a lack of incorporation of iron in hemoglobin.[13]

CONCLUSION

High prevalence of occupational morbidities and higher odds of alteration of serum cholinesterase levels in exposed workers of floriculture industry point towards formulation of appropriate safety norms for them in India. It may be noted that exposure of an individual farmer who applies pesticide once or twice a year is much less than that of workers in commercial farms who are exposed nine hours a day for many consecutive days.

Presence of exposure was the only factor that had a statistically significant association with low serum cholinesterase levels. This can be a modifiable factor with use of appropriate personal protective measures. As sprayers had four times higher odds of low serum cholinesterase levels they should be frequently rotated to perform duties where exposure is absent or less. Further it is imperative that periodic serum cholinesterase levels be monitored for all workers or for at least those who are exposed.

Limitation of our study is that it was carried out in a limited geographical area. Recall bias for morbidities was inevitable .Also there was no pre placement medical and laboratory examination. Hence a comparison with pre placement baseline serum cholinesterase level could not be done.

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