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Profile of plant growth regulator poisoning: A two-year study.

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ABSTRACT

Poisoning is an important global public health problem causing significant morbidity and mortality requiring sufficient attention. Plant growth regulators are the compounds having similar physiological and biological effects to those of plant hormones therefore they are used widely in agroforestry with intention to increase the yield and quality of agricultural products. The residues of plant growth regulators are seriously detrimental to human health. This study was carried out at Forensic Medicine department of Government Medical College and hospital during 1st January 2018 to 31st December 2019 on 24 cases died due to plant growth regulator poisoning with purpose to highlight the toxic effects of plant growth regulators which impose the health hazards to human and animals including serious organ damage and death.

INTRODUCTION

Poison is a substance which cause serious and life threatening damage to the body by means of ingestion, inhalation or injection.[1] Poisoning in a specific geo graphical region or area depends on various factors which include availability of poison, access to the poison, socioeconomic status of an individual.[2] Fatal poisoning rates in low-income and middle-income countries are four times that of high-income countries. The common poisoning agents in high-income countries include pharmaceuticals, bleaching agents, cleaning agents, pesticides etc. The common poisoning agents in low-income and middle-income countries include paraffins and kerosene, pharmaceuticals and cleaning agents.[3] Plant growth regulators or phytohormones are organic substances produced naturally in higher plants, controlling the growth or other physiological functions at a site remote from its place of action and they have similar physiological and biological effects to those of plant hormones so, they are used widely in agriculture.[4] Plant growth regulators include various classes such as auxins, gibberellins, cytokinin, ethylene, growth retardants and growth inhibitors.[4] Some new compounds do not fit neatly into these classifications but are described as having effects that resemble those for known plant growth regulators.[5] The residues of plant growth regulators in agricultural products are seriously detrimental to human health because they have been found with hepatotoxicity, nephrotoxicity, genotoxicity, neurotoxicity, even carcinogenicity and teratogenicity. Furthermore, plant growth regulators are suspected to disrupt the function of human and animal reproductive

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systems.[6] In India poisoning is one of the most common means adopted for committing suicide, besides this it is also the major cause of accidental poisoning owing to vast use of chemicals product in agroforestry and rapid industrialization.[7] The rate of poisoning increased from 26.0% in 2014 to 27.9% in 2015 and it also the poison constitutes the major causes of accidental deaths during 2015 with 6.3% cases.[8] This is only a tip of iceberg as most of the cases were goes unreported in developing countries like India. We carried out this study on deceased cases brought for postmortem examination died due to plant growth regulators including chlormequat, Glyphosate, Nitro benzene, 2, 4 Dimethylamine, Hydrogen cyanamide and nitrobenzene with purpose to highlight the toxic effects of plant growth regulators which impose the health hazards to human and animals including serious organ damage and death.

MATERIAL AND METHODS

The longitudinal prospective study was undertaken at Dept. of Forensic Medicine Government Medical College and hospital. Total about 1450 postmortem examinations were conducted during 1st January 2018 to 31st December 2019 in this hospital. In these 1450 cases, 147 cases had history of death due to poisoning as per police inquest and requisition letter. On those 147 cases of poisoning postmortem examination were conducted and viscera was preserved for chemical analysis. Among these cases 24 cases either had history of plant growth regulator poisoning or findings of plant growth regulator poisoning or treated for plant growth regulator poisoning or chemical analysis report was positive for plant growth regulators was considered for demographic study in terms of age, sex, marital status, hospitalization, religion, occupation manner of death and type of poison consumed.

RESULTS

We observed that out of total 24 cases, 14 cases (58.33%) were male and 10 cases (41.66%) were female. The minimum age was 11 years and maximum age was 55 years and the mean age was 33 years. Total 2 cases belong to 11-20 age group which were female, 6 cases (25%) belong to age group 21-30 years in which 2 were male and 4 were female, 8 cases (33.33%) belong to age group 31-40 years in which 5 were male and 3 were female, 7 cases (29.17%) belong to age group 41-50 years in which 6 were male and 1 was female, 1 case (4.17%) belong to age group 51-60 years which was male (Table 1). Among 24 cases died due to plant growth regulators 9 cases (37.50%) were died due to chlormequat poisoning in which 6 were male and 3 were female, 4 cases (16.16%) were died due to Hydrogen cyanamide poisoning in which 3 were male and 1 was female, 5 cases (20.84%) were died due to Glyphosate poisoning in which 1 was male and 4 were female, 4 cases (16.16) died due to 2,4-Dimethylamine poisoning in which 2 were male and 2 were female. 2 cases (8.33%) died due to Nitrobenzene poisoning in which all the 2 were male (Table 2). We found that in 24 cases, 16 cases (66.66%) died due to suicidal poisoning in which 7 were male and 9 were female, 3 (12.50%) died due to accidental poisoning in which 2 were male and 1 were female, and in 5 cases (20.84%) manner of death was not known (Table 3). Among the total 24 cases died due to poisoning 3 cases (12.50%) were admitted in hospital for less than 24 hours, 3 cases (12.50%) were admitted for 24 to 48 hours and 48 to 72 hours each. 8 cases (33.34) were admitted for more than 72 hours and 7 cases (29.16) were brought dead to this hospital which were either found dead or died during traveling while bringing to hospital for treatment purpose (Table 4). Considering the marital status, 6 Male and 12 Female were married and 2 Male 4 Female were single. Out of total 24 cases 3 male and 5 female belongs to urban locality however 11 male and 5 female belongs to rural locality. 10 male and 6 female cases belongs to Hindu community, 2 male and 2 female belongs to Muslim community and 2 male 2 female belongs to Buddhist community.

The autopsy findings in all the cases hospitalized for less than 3 days were almost same. The brain was oedematous with diffuse petechial hemorrhages were seen over the surface. Both lungs were congested and oedematous on cut section frothy fluid oozes out. Upper airway and esophagus were oedematous and congested with petechial hemorrhages seen. Stomach showed congestion and hemorrhagic patches. In acute cases unpleasant odour was perceived. Kidneys showed gross congestion. Liver and spleen were normal. As the days of hospitalization increases, findings of multiorgan failure seen prominently including septicemia.

DISCUSSION AND CONCLUSION

Plant growth regulators were first discovered in plants at the beginning of the 20th century.[5] Thimmann

Table 1: Age and Gender wise distribution of poisoning deaths.

Age groups	Male	Female	Total	Percentage
0-10	0	0	0	0
11-20	0	2	2	8.33
21-30	2	4	6	25
31-40	5	3	8	33.33
41-50	6	1	7	29.17
51-60	1	0	1	4.17
Total	14	10	24	100

Table 2: Distribution of poisoning deaths as per type of poison consumed.

Type of poison	Male	Female	Total	Percentage
Chlormequat	6	3	9	37.50
Hydrogen cyanamide	3	1	4	16.16
Glyphosate	1	4	5	20.84
2,4 Dimethylamine	2	2	4	16.16
Nitrobenzene	2	0	2	8.34
Total	**14**	**10**	**24**	**100**

Table 3: Distribution of poisoning deaths as per manner of death.

Manner of death	Male	Female	Total	Percentage
Suicidal	7	9	16	66.66
Accidental	2	1	3	12.50
Not Known	5	0	5	20.84
Total	**14**	**10**	**24**	**100**

Table 4: Distribution of poisoning deaths as per duration of hospitalization.

Duration of hospitalization	Male	Female	Total	Percentage
< 24 hrs	2	1	3	12.50
24-48 hrs	2	1	3	12.50
48-72 hrs	2	1	3	12.50
> 72 hrs	4	4	8	33.34
Brought dead	4	3	7	29.16
Total	**14**	**10**	**24**	**100**

(1948) proposed the term Phytohormone for plant growth regulators as these hormones are synthesized in plants.[4] Endogenous plant growth regulators are the plant hormones synthesized in one part of a plant and translocated to another part of a plant where it causes a physiological response in a very low concentration. As knowledge and commercial use of plant growth regulators grew, compounds formerly extracted could be synthesized, thus plant growth regulators are now both, natural (extracted) and synthetic (synthesized) in origin.[4] Plant growth regulators are to be registered by the U.S. Environmental Protection Agency, its use as recommended on the label must be safe for the plant, its applicator, and the environment as far as can be feasibly determined.[5] Thus, neither plant nor human injury is to be expected from most properly applied plant growth regulators. If properly used, plant growth regulators have an excellent safety record. However, if the wrong concentration is used, if safety equipment is not properly used, or if the application times are not correct, poisoning can occur in plants, animals, and humans.[5] Chlormequat poisoning clinically resembles anticholinest erase insecticide poisoning. The cholinergic symptoms result from direct action on nicotinic and muscarinic receptors and not from inhibition of the cholinesterase activity. Chlormequat is not approved for use in in USA but it is approved in Europe.[9] Glyphosate is an herbicide applied to the leaves of plants to kill both broad leaf plants and grasses. The sodium salt form of glyphosate is used to regulate plant growth and ripen specific crops.[10] Nitrobenzene is a pale-yellow oily liquid with an odor of bitter almonds. Recently it is also used as a plant growth nutrient. Nitrobenzene is a combination of nitrogen and plant growth regulators that act as plant energizer, flowering stimulant, and yield booster.[11] 2,4-Dimethylamine is an herbicide and secondarily a plant growth regulator. Formulations include esters, acids, and several salts, which vary in their chemical properties, environmental behavior, and to a lesser extent, toxicity.[12] Hydrogen cyanamide have frequently been used to break dormancy in grape vine floral buds. However, the exact underlying mechanism remains elusive.[13] Very few cases were found in literature regarding the plant growth regulator poisoning. Nisse P. et al (2015) examined case report of seven cases on death due to chlormequat poisoning.[5] Bardale R. et al (2015) also reported similar case of chlormequat chloride poisoning in western Maharashtra region.[14] Xu CS et al (2018) studied the toxicological characteristics of plant growth regulators and their impact on male reproductive health.[5] Boumrah Y. et al

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(2015) conducted study on Suicide by self-injection of chlormequat poison in to the abdominal muscles which leads to death[15]. Vijitharan V. et al (2016) observed the case of chlormequat poisoning in Sri Lanka[16].

The Sangli District is located in south-western part of Maharashtra. This part is blessed with Krishna River. Therefore, the agriculture flourishes in this region having crops like sugarcane, grapes, pomegranates, turmeric and various types of vegetables, so the plant growth regulators are widely used in agriculture to get high yield and good quality of agricultural products. This leads to increase in number of poisoning by plant growth regulators. We compared this data with previous years poisoning cases of death due to plant growth regulators in this hospital and we noted that cases are increasing day by day. The current study highlights the depth of problem which is serious and worrisome, and needs utmost attention and awareness strategies regarding the safety use of products, precautions, prevention of poisoning and management of cases.

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