Green tobacco sickness (GTS) is the condition that mainly affects the tobacco harvesters. The present review was conducted to discuss the etiology, epidemiology, symptoms, and prevention of GTS. It is caused by the absorption of nicotine through the skin while the workers are engaged in handling the uncured tobacco leaves. The symptoms include nausea, vomiting, pallor, dizziness, headaches, increased perspiration, chills, abdominal pain, diarrhea, increased salivation, prostration, weakness, breathlessness, and occasional lowering of blood pressure. The prevalence of GTS varies from 8.2 to 47% globally. The use of personal protective equipment like water-resistant clothing, chemical-resistant gloves, plastic aprons, and rain-suits with boots should be used by the tobacco farmers to prevent its occurrence. An international-level awareness campaign has to be taken up and more stringent workers safety regulations have to be formulated.

**Keywords:** Green tobacco sickness, health hazards, nicotine, tobacco harvesters

**INTRODUCTION**

Tobacco growing in the field or in an uncured state is called “green tobacco.” This is toxic when in prolonged direct contact with the skin. Workers engaged in tobacco cultivation suffer from an occupational illness known as “green tobacco sickness” (GTS). The illness was first reported among tobacco workers in Florida, in 1970, as “cropper sickness.” Later, it was found to be caused by the absorption of nicotine from wet tobacco plants and reported as GTS. GTS is an acute form of nicotine toxicity and usually occurs several hours after continuous exposure to green tobacco leaves. It is a sickness that is not well documented and is often underreported because many of those who experience GTS are not able to interpret their ailment or its cause.

**Etiology**

The etiology is not clear, but according to Gehlbach et al. (1974, 1975), it is caused by the absorption of nicotine through the skin while the workers are engaged in handling the uncured tobacco leaves. Nicotine, found in tobacco plants, is soluble in water, causing it to be drawn out onto the surface of the leaves by rain, dew, or perspiration. From there, the nicotine is absorbed through the skin, where it passes directly into the bloodstream and is distributed throughout the body.

The nicotine alters part of the brain, causing reflex vomiting, and excites nerves in the gastrointestinal tract that bring about nausea and abdominal cramping. Physical exercise and high ambient temperatures can increase absorption of nicotine. Some risk factors identified for GTS are age, environmental conditions, personal tobacco use, and type of labor performed. It was observed that older workers were less likely to develop GTS, possibly because younger workers who are sensitive to nicotine leave the workforce. Workers that used tobacco products were less likely to suffer from GTS because of tolerance to the effects of nicotine. Laborers working in hot, wet conditions are more likely to develop GTS because the wetness and high humidity causes nicotine to reside on the surfaces of the leaves, while the high ambient temperature increases skin absorption, thereby increasing plasma nicotine concentrations by 30–45%. The combination of high ambient temperatures and hard physical labor shunts blood to the skin to help lower body temperature. The resultant increase in surface blood flow also significantly increases dermal absorption of nicotine. Some tasks involved in

**Address for correspondence:** Dr Shailee Fotedar, Department of Public Health Dentistry, H.P. Govt. Dental College, Shimla, Himachal Pradesh, India.

E-mail: drfotedar@rediffmail.com

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

**How to cite this article:** Fotedar S, Fotedar V. Green tobacco sickness: A brief review. Indian J Occup Environ Med 2017;21:101-4.
Symptoms

The symptoms include nausea, vomiting, pallor, dizziness, headaches, increased perspiration, chills, abdominal pain, diarrhea, and increased salivation, prostration, and weakness, depending on the exposure, but are of short duration. These symptoms can be conveniently referred to as neurological complaints. Other symptoms like a cough with or without expectoration and breathlessness are regarded as respiratory complaints, and occasional reduction in blood pressure or heart rate. Among those susceptible, the average length of the illness, with treatment, is between 1 and 3 days (median ~ 2.4 days).

Symptoms of GTS are similar to those induced by pesticide exposure or heat exhaustion, and to nicotine intoxication experienced by novice smokers. Thus, GTS may be misdiagnosed by practitioners unfamiliar with this condition. Although GTS has not been associated with mortality or long-term morbidity, it causes significant discomfort and lost productivity among tobacco workers.

Some of the symptoms of GTS are similar to those of organophosphate poisoning and heat exhaustion. However, many of the symptoms of organophosphate poisoning (including increased lacrimation, pulmonary edema, and miosis) have not been associated with GTS. The possibility that GTS symptoms are due to pesticide poisoning is lessened because the last application of pesticides normally occurs several weeks before harvest and because GTS is known to occur among workers on farms that do not use pesticides. Furthermore, the cases of GTS were documented before widespread pesticide use.

Symptoms of heat exhaustion have been ruled out in many cases of GTS. Although tobacco is typically harvested during hot weather, GTS symptoms have also appeared during cool conditions when harvester reported feeling chilled rather than overheated. Also, most of those stricken with GTS became ill after they had gone home for the day (median onset = 10 hours).

Diagnosis

GTS is self-limiting and of short duration. Despite the relatively short duration of GTS, the illness can be debilitating during its onset and progression. Clinical diagnosis of GTS is based on both the presence of symptoms described above and a history of harvesting tobacco. The diagnosis of GTS may be made by testing the blood or urine for nicotine (half-life = 3–4 hours) or cotinine [a nicotine metabolite (half-life = 36 hours) that can also be detected in saliva]. Although the level of cotinine has been used to distinguish between tobacco users and nonusers, the level cannot be used to distinguish between heavy tobacco users and persons with GTS because nicotine/cotinine concentrations that represent toxic levels have not been established.

Epidemiological data

Internationally, the effects and prevalence of GTS are not well known. GTS has been described in tobacco farm workers in several regions in the USA, Japan, India, Poland, and more recently in Brazil. The first medical report of GTS was published in 1970 based on cases in Florida. Reports of GTS have since been published describing its occurrence in North Carolina among white farmers and Latino farm workers as well as in Kentucky. India, Gujarat, and Japan. Data on GTS incidence or prevalence are limited. Gehlbach et al. reported the earliest estimate of GTS prevalence, stating that “during the 1973 harvesting season, an estimated 9% of North Carolina’s 60,000 tobacco growers reported illness among their workers.” CDC reported that the crude 2-month incidence rate for hospital treated GTS in Kentucky during 1992 was 10 per 1000 workers. Quandt et al. found 41% of 144 Latino migrant and seasonal farm workers interviewed at the end of the 1998 season in North Carolina reported having GTS at least once during that season. In an epidemiological study in Brazil in a population of 2469, the prevalence of GTS among males was 6.6% and among females 11.9%. The few existing studies show great variability in GTS prevalence of between 8.2 and 47% during the tobacco-growing season. High prevalence variability may be related to methodological differences in the studies or differences in the work process.

India is the third country to have reported GTS among tobacco harvesters. Cross-sectional studies were carried out to assess the prevalence of GTS among tobacco harvesters in four villages of Gujarat, where tobacco is cultivated mainly for making beedis, chewing tobacco and snuff, as well as in a research farm of the Central Tobacco Research Institute (CTRI) at Andhra Pradesh, where mainly cigarette tobacco is grown. The overall prevalence of GTS was higher (86.2%) among beedi tobacco cultivators compared to cigarette tobacco cultivators (60.6%), and in chewing and snuff tobacco cultivators (47.0%). Among men, the proportion of workers with GTS was higher in the chewing and snuff tobacco-growing areas of Anand, Gujarat, than in the cigarette tobacco-growing area of Andhra Pradesh. No symptoms were reported among the control group.

The studies carried out by the National Institute of Occupational Health (NIOH) in CTRI farms in Andhra Pradesh reveal discoloration of the skin for workers coming into contact with tobacco leaves. Even the storage of tobacco in houses was found to lead to higher incidences of nausea, headache, and dizziness. (For example, many women lose the taste for food, and the smell and bitterness of tobacco is passed on to the food that is prepared in the houses where tobacco is stored.) Likewise, the dust generated during the processing of tobacco was found to result in allergies among the workers.

The magnitude of GTS has not been assessed in sufficient detail and most published research on GTS is descriptive studies.
Treatment is also discussed rarely. As the tobacco industry expands production capabilities to the developing world, greater numbers of workers will be exposed to GTS and thus international studies of GTS are badly needed.

**Cost**

As reported by Boylan, a quarter of those stricken with GTS who sought medical treatment required hospitalization, and significant hospital expenditures are associated with the condition.

GTS-induced hospital expenses are estimated to average US$250 for outpatient treatment, $566 for hospital admission, and $2041 for intensive care treatment.\[^{26}\] However, no such estimate has been reported in India.

**How to prevent green tobacco sickness**

Employers should provide workers with information and training about nicotine hazards, GTS prevention, and appropriate personal protective equipment (PPE) before letting the workers handle tobacco leaves.

a) Train workers to recognize GTS signs and symptoms and to alert supervisors if they develop symptoms or notice any other workers exhibiting symptoms

b) Train supervisors to ensure that any worker with GTS symptoms immediately drinks water and rests in the shade, in addition to receiving medical attention if necessary

c) Employers should encourage workers to share it with healthcare providers to avoid misdiagnosis if symptoms occur. Nicotine poisoning, heat-related illnesses, and pesticide poisoning share similar symptoms. When seeking medical care, it is important to give doctors and other medical staff complete information about the patients’ job activities and the crops they work with, so that patients receive the correct treatment

d) The employer must train each worker on how to use PPE. Training should include information about how clothing can be used as PPE and how some clothing may no longer provide adequate protection if it becomes wet. Gloves, long sleeve shirts, long pants, and water-resistant clothing are recommended to prevent exposure to nicotine from tobacco leaves. Employers should train workers on how to care for and clean their clothing to ensure that it protects them from nicotine exposures. Employers are required to provide laundry facilities if workers are housed at a temporary labor camp.\[^{27}\]

i) **Gloves** will protect workers handling tobacco leaves from nicotine absorption through their hands. If gloves are wet, they become less protective

ii) **Long sleeve shirts and pants** protect workers from nicotine absorption if tobacco leaves come into contact with their arms or legs. However, once the clothing becomes wet with rainwater, dew, or sweat, it no longer provides adequate protection and may increase absorption risk. Employers should ensure that worker-owned clothing, used to protect against nicotine exposure through tobacco leaves, is dry. For example, employers should allow workers to change out of wet clothing and into dry clothing, as needed, throughout the workday

iii) **Water-resistant clothing** (e.g., rain suits) keeps dew or rain, which had contact with tobacco leaves, from contact with skin and clothing to protect workers from exposure to nicotine contained in the water. Water-resistant clothing is considered defective or damaged when dew or rain containing nicotine is able to reach the skin through tears or openings and should not be used. If working in the heat with water-resistant clothing, employers must provide additional opportunities for water, rest, and shade due to increased heat illness risk

e) Washing with soap and water immediately after working is recommended to reduce exposure to nicotine. Washing can reduce the amount of nicotine that is on skin by 96%. Employers must provide handwashing facilities to workers and, if housed in a temporary labor camp, showering facilities in that camp.\[^{28}\]

**Conclusion**

Tobacco harvesters can be exposed over large portions of their body despite wearing work clothing due to substantial contact with tobacco that may be wet with dew. Contact with wet tobacco and wearing work clothes that have become wet from dew or perspiration may increase exposure and absorption of nicotine through the skin. GTS can be avoided with the proper precaution. So, one must know that the crop they are working with can cause them harm. It is suggested that croppers should avoid harvesting in the rain or should begin harvesting after the dew evaporates. Public awareness campaign on GTS at the national and international level should be taken up regarding workers health regulations. A strong regulatory effort must be undertaken to address the potential hazards of GTS.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Weizenrecker R, Deal WB. Tobacco cropper’s sickness. J Fla Med Assoc 1970;57:13-4.
2. McBride JS, Altman DG, Klein M, White W. Green tobacco sickness. Tob Control 1998;7:294-8.
3. Gehlbach SH, Williams WA, Perry LD, Woodall JS. Green-tobacco sickness: An illness of tobacco harvesters. JAMA 1974;229:1880-3.
4. Gehlbach SH, Perry LD, Williams WA, Freeman JL, Langone JJ, Peta LV, \textit{et al}. Nicotine absorption by workers harvesting green tobacco. Lancet 1975;1:478-80.
5. Homisy W, Yan K, Houle JM, Bensner JG, Gossard D, Pierce CH, \textit{et al}. Plasma levels of nicotine and safety of smokers wearing transdermal delivery systems during multiple simultaneous intake of nicotine and during exercise. J Clin Pharmacol 1997;37:728-36.
6. Vanakoski J, Seppala T, Sievi E, Lunell E. Exposure to high ambient temperature increases absorption and plasma concentrations of transdermal nicotine. Clin Pharmacol Ther 1996;60:308-15.
7. Ghosh SK, Parikh JR, Gokani VN, Rao MN, Kashyap SK,
Chatterjee SK. Studies on occupational health problems in agricultural tobacco workers. J Soc Occup Med 1980;29:113-7.

8. Boylan BB, Brandt V, Muehlbauer Auslander M, Spurlock C. Green tobacco sickness in tobacco harvesters—Kentucky, 1992. MMWR 1993;42:237-40.

9. Ballard T, Ehlers J, Freund E, Auslander M, Brandt V, Halperin W. Green tobacco sickness: Occupational nicotine poisoning in tobacco workers. Arch Environ Health 1995;50:384-9.

10. Edmonson WD, Smith BD, Morgan HJ. Green tobacco sickness (bradycardia in a young farmer). J Tenn Med Assoc 1996;89:85-6.

11. Gehlbach SH, Williams WA, Perry LD, et al. Nicotine absorption by workers harvesting green tobacco. Lancet 1975;1:478-80.

12. McKnight RH, Koetke CA, Donnelly C. Familial clusters of green tobacco sickness. J Agromed 1996;3:51-9.

13. Hipke M. Green tobacco sickness. Southern Med J 1993;86:989-92.

14. Ghosh S, Gokani VN, Parikh JR, Doctor PB, Kashyap SK, Chatterjee BB. Protection against “green symptoms” from tobacco in Indian harvesters: A preliminary intervention study. Arch Environ Health 1987;42:121-3.

15. Ghosh S, Gokani VN, Doctor PB, Parikh JR. Intervention against “green symptoms” among Indian tobacco harvesters. Arch Environ Health 1991;46:316-7.

16. Satora L, Gomolka E, Biedron W. Green tobacco sickness in Poland. Pol Arch Med Wewn 2009;119:184-6.

17. Quandt SA, Arcury TA, Preisser J, Norton D, Austin C. Migrant farmworkers and green tobacco sickness: New issues for an understudied disease. Am J Ind Med 2000;37:307-15.

18. McKnight RH, Levine EJ, Rodgers GC Jr. Detection of green tobacco sickness by a regional poison center. Vet Hum Toxicol 1994;36:505-10.

19. McKnight RH, Dawson SK, Westneat SC, et al. Delay among the general public in telephoning a poison center. Vet Hum Toxicol 1996;38:92-5.

20. Ghosh SK, Parikh JR, Gokani VN, Kashyap SK, Chatterjee SK. Studies on occupational health problems during agricultural operation of Indian tobacco workers. J Occup Med 1979;21:45-7.

21. Misono J, Koyama W, Miura H. Two cases of green tobacco sickness in the tobacco harvesters and the absorption of nicotine through the skin in the rat. Jpn J Ind Health 1983;25:3-9.

22. CDC. Green tobacco sickness in tobacco harvesters. MMWR 1993;42:237-9.

23. Anaclaudia GF, Neice MF, Rodrigo DM, Nadia SF, Vanessa IM, Luiz AF. Green tobacco sickness among tobacco farmers in southern Brazil. Am J Ind Med 2014;57:726-35.

24. National Institute of Occupational Health (NIOH). Studies on occupational health problems in tobacco workers. Annual report. Ahmedabad: NIOH; 1977:273.

25. NIOH. Occupational health problems of tobacco harvesters and their prevention. Annual Report. Ahmedabad: NIOH; 2000:7.

26. Centers for Disease Control and Prevention (CDC). Green tobacco sickness in tobacco harvesters—Kentucky, 1992. MMWR Morb Mortal Wkly Rep 1993;42:237-40.

27. Recommended Practices: Green Tobacco Sickness. National Institute for Occupational Safety and Health: 2015.

28. Curwin BD, Hein MJ, Sanderson WT, Nishioka MG, Buhler W. Nicotine exposure and decontamination on tobacco harvesters’ hands. Ann Occup Hyg 2005;49:407-3.