

# Herbicide: The Cause of Haze and Corresponding Counter Measurements

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**Abstract:** The main cause of serious haze in China is firstly pointed out to be vast spraying herbicide. Several interesting tests demonstrate hazards of spraying herbicide and its connection to haze concerning formation of poisonous gas and tiny powders. Respiratory infectious disease is also presumed to have some connection to herbicide. In terms of countermeasures, burning firewood and domestic garbage in suitable stove near trees is pointed out to be effective way to fight against herbicide and haze through decomposing poisonous gas in high temperature and absorption tiny poisonous powders by high temperature oil steam.

**Keywords:** Haze, Garbage Disposal, Burning, Countermeasures, Respiratory Diseases.

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## I. INTRODUCTION

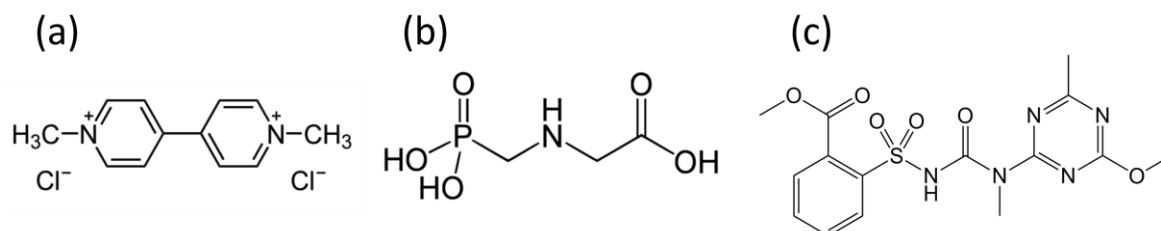
In China, haze has been a serious problem [1]. In winter, air visibility is poor that it is usually full of fog. However, if it is true fog which is normally full of water vapour, one go through it will make the cloth wet. The type of fog called haze is dry. People dare not to go out unless wear masks because of uncertain negative influence on health. Haze in China contains a lot of very tiny powders which usually measured by PM 2.5 indexes [2]. In summer, though thank to wind blowing from the ocean and higher temperature, haze would reduce, the air is still not as clear as before. Haze covers the earth as cotton-padded, prevent animals and mankind from breathe normally so that creatures get not as dynamic as before. People are easy to feel tired though just making a little effort; for plants, haze blocks both breath and photosynthesis, which hinders normal circulation of carbon dioxide and oxygen in atmospheres.

With respect to the cause of haze, many reasons such as burning coal for warmth in north China, burning straw, increasing number of cars and industry etc [3-5] have been put forward. However, those reasons seem to be unpersuasive that similar situations also have happened in the past or in other countries, but they have not lead to so serious haze. For example, firstly in 1980-1990s, burning the coal for warmth in winter was very popular in many cities of north China, countless coal stoves were burning and releasing gas to air, but the atmosphere was quite fresh then; secondly, burning straws after harvest has been a traditional cultivation way for several hundred years; thirdly, in rural regions of north China, vehicles are truly not many, but haze is still serious. There must be other critical reasons lead to the serious haze.

Haze usually covers over the vast farmland on the north plain of China. Keeping in mobile state the haze is usually not evenly distributed in air. It is observed that when heavy haze goes through vegetable field, the trace is especially evident that vegetable lack of vitality. Haze probably contains substances similar to herbicides.

Environmental changes are usually associated with great economic and social evolutions. In China, for more than decades, farming method has greatly changed. Agricultural agents especially the herbicides are vastly used in farm land and green belts every year to save labor, herbicides have almost replaced manual weeding. The poisonous herbicides are to some degree similar to orange agent (defoliating agent) that had been sprinkled by American army during the Viet Nam war to kill trees and prevent the Viet Nam ground army in woods to threaten American planes, which had lead to many born-deformed baby more than twenty years later [6-7]. Though, herbicides used now are claimed to be probably not as

poisonous as orange agent, the hazards of herbicides are still unclear [8-9]. Several studies have observed high concentrations of ammonium and organic carbon in Beijing and Shanghai recently during severe regional haze events [10-12]. Secondary inorganic pollutant mass concentrations ( $\text{NO}_3^-$ ,  $\text{SO}_4^{2-}$  and  $\text{NH}_4^+$ ) were found to be 6 times higher in haze weather than clear days [13]. It is reasonable that some functional group of herbicides such as paraquat, glyphosate, Tribenuron-methyl (see Fig. 1) and so on convert to these pollutions in natural revolution process.



**Fig. 1** Molecular structure of three herbicides: (a) paraquat, (b) glyphosate, (c) Tribenuron-methyl

## II. TEST

To confirm the hypothesis, several tests as follows were done in Fujian state, south part of China to investigate these issues.

### 1. Spraying herbicides in Flower Pot and Green Belt

Take two flower pots, put some humus earth in them, and plant the same plants in it respectively. One pot was sprayed the diluted glyphosate occasionally to control weed, and the other was manually weeded. Both plants were watered in the same way. Several weeks later, the volume of soil having been sprayed herbicides decreased, loosen humus had to be added continuously to keep the plants alive. The volume of soil in other pot changed little. Two greenbelts were tested in the same way. On one side, herbicide was used to restrain weeds, and other side was manually weeded. A period later, for the one sprayed herbicides, the soil surface fell and the amount of earth decreased, and in windless weather, the air above is usually not as clear as the other green belt, which is just like haze. Put cage raising some chickens was put on each green belt. Enough food, water and space were provided for chickens. Several days later, chickens on the herbicide-sprayed green belt died, and those on the green belt without herbicide were still alive.

The test implies that herbicides will lead to earth loss which may have converted to tiny suspended powders in haze, and the atmospheres produced by herbicide is poisonous to animals.

### 2. Influence of herbicides on the longan tree

Choose two longan woods which were both made up of dozens of longan trees. One wood was used herbicides for fruit trees to weed, efficient and labor-saving. The other was manual weeding, time and labor-consuming. Several days later, some leaves of the one spraying herbicides fell, and the remaining ones looked gloom. The herbicides-sprayed trees then found to be easy to get insect damage so more pesticide was needed. Additionally, similar to test 1, observed from far away, the air on the woods was not clear.

Several years later, taste ripe fruit of them, it is easy to get fed up by just eating one or two longan fruits from the trees weeded by herbicides. However, the poisonous gas will absorb by fruit trees and result in unhealthy fruits so that one can easily eat a big string of longan fruits from the trees not being sprayed the herbicides. The test implies that longan trees sprayed herbicides grow bad and get poor pest resistivity.

### 3. Feeling of tiny powder on land

There was a one-kilometer long cement road on the mountain. Two greenbelts on both sides along the road were sprayed broad-spectrum herbicides occasionally to restrain weed. When it was rainy heavily, walking barefoot on the road, one would feel the bottom of feet clean. After the rain stopped and the road got dry, if finish the same journey barefoot, the feet bottom would feel hot that the surface cuticula on the feet bottom was a little scrapped off by some tiny powder which have descend with rain water from the air.

There lived a family half-way up the hill cooking by fire wood. The smoke was discharged from a long chimney. When walking barefoot up the road, the fine powders felt under feet became less as approaching the family house, hardly any fine powders can be felt when passing beside the house. However, if walking away the house, the fine powders were gradually increasing.

Push a bicycle upward the road, one would breathe very hard and feel physical-exhausting. However, when passing the family with the cooking smoke rising up from the chimney, smelling the mixed faint scent of burning leaves and firewood, one would feel relax and push the bike more easily. It seems that cooking with firewood may eliminate negative influences of spraying herbicides. To certify the assumption, further tests were done.

#### **4. Clean the air by burning firewood**

The cooking stove in the house of the family was connected to a long chimney crossing the roof (see Fig. 2). Foliage of trees planted around the house was found to grow toward the chimney, luxuriant and green. Hence, cooking smoke from the chimney would promote growth of trees.



**Fig. 2** The long chimney connected to cooking stove crossing the flat roof with trees growing toward it.

Put some pots were in different sites of the vacant land near the chimney to hold rainwater, when it was raining. It was found that the nearer to the chimney, the clearer the rainwater collected was. Moreover, if wind blew cooking smoke going over certain pots constantly, the collected rainwater in these pots was clearer too. The result illustrate that the cooking smoke from the chimney can eliminate tiny powders in air.

#### **5. Reaction of Poultry to spraying the herbicides and burning fire wood**

It is said that avian are sensitive to environment pollution such as dioxins and dioxin-like compounds [14] which are important compositions in herbicides. Interestingly, cocks were used to detect biochemical weapons in second Gulf War by the American Army. Here, chickens were used to investigate influence of spraying herbicides in the test. A flock of chickens and ducks were normally raised on the ground of a mountain forest. They were feed with enough grain and water every day. There had grown heavy weeds on the ground. Since one day, forest worker had used pesticide and herbicides regularly to restrain insect and weed since then. Some years later, the whole mountain forest got deadly quiet without insects and birds. The air was always not fresh. One walks on the path in the forest is easy to get confused and lose the way. Sometimes, died bird can be seen. If the climate changed suddenly, flocks of brood chickens and ducks would die suddenly.



**Fig.3** Chickens and ducks liked to stay and take rest near the edge of the stove

A 1.5 meter high column-shaped stove made of stone with a three-meter high shed was built on the empty land. Burn the fire wood, surplus food and rasorial feces that had been dried in the sun in the stove. Free-raising chickens and ducks were found to be liked to stay and take rest on the top edge of the stove rather than be afraid of smoke generated by burning near the fire (Fig. 3). Groups of birds would come around the stove and enjoy the pleasure of burning fire. After the stove start to be continuously used, the forest recovered vitality, even climate changed suddenly; chickens and ducks still lived healthily. The test illustrate that burning firewood can change the poisonous atmosphere made by herbicides and other agriculture agent so that poultry can live better.

#### 6. How to swim securely in hills reservoir around which herbicides had been sprayed.

Recently, the news about drowning are rather frequent in China, even many skilled swimmer get drowning. There were hills being turned into tea garden. The low tea trees looked pleasing. There built a dam half way up the hill, and a water reservoir of several-hundred square meters area formed. The water was clear, but there were no weeds waterside because of herbicides. No sign of life in the area, the tea woods were quiet. The local tea peasant said: Never swim in the pond. It is easy to get drowning there. Nobody dared to swim in the water. The safe swimming method is not taking a breach on the water surface: Stand on the high place, take a deep breath and dive into the water, after one or two minutes, climb up and breathe. If breathing on the water surface, swimmers are easy to get leg cramp and drowning. In addition, Swimming near a firewood-burning stove located by the side of water surface is also a plausible way. The test illustrates that on the water surface which is the lowest space in the wood, the concentration of poisonous gas on the water surface is the highest.

### III. DISCUSSION

From the above tests, the harmful product of spraying herbicides can be inferred (see Fig. 4). Firstly, herbicides sprayed in the earth would react with the substance in the soil and produce poisonous gas. The specific gravity of this gas was higher than air; it normally stays on the surface of land and water. It greatly reduce air cleaning ability of plants, so in haze weather, the concentrations of traditional pollutions are usually high [15]. Secondly, herbicides also corrode soil that the soil gradually lost and turn to poisonous tiny powders in haze. Molecules of herbicides are active enough that the reaction is possible. Tiny poisonous powders (TPP) produced in the process distributes in atmosphere, being compressed or dispersed. When being compressed, the haze formed.

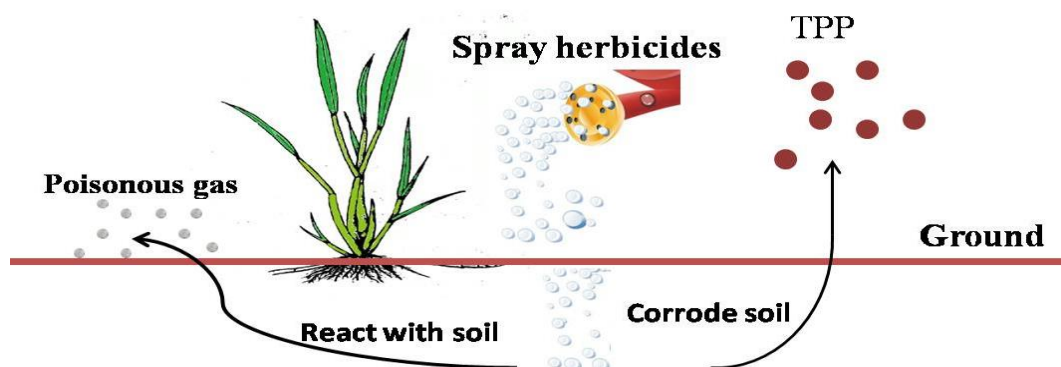


Fig. 4 the reaction of herbicides and soil

In previous research, TEM analysis have discovered that many haze particles are mixtures of organic compounds and inorganic substance containing several earth-abundant elements such as Ca Si Al Zn [2,16], which agree with these result. The corrosion effect of herbicides would also lead to hill landslide, debris flow and dust storm easily.

For the animals live in heavy haze, the possibility of getting respiratory diseases disease may be higher than others. The birds flying fast in the haze air every day are especially easier to absorb excessive poisonous powders in their lung, weakening their resistance to avian influenza virus (AIV) [17] In the recent years, Chinese epidemic situation of avian influenza is usually serious in cold haze season. Additionally, the severe acute respiratory syndrome (SARS) [18], another respiratory infectious disease which also normally happens in cold season may be also to some degree related to herbicides.

Find the method to reduce the danger of herbicides is an urgent topic at the moment. As mentioned above, burning firewood in stoves has been found to be a useful way. The simple mechanism and other countermeasures are discussed below.

### 1. Ban to produce and sell herbicides

As mentioned above, Weeding by herbicides is short-term convenient but long-term harmful. Thus, ban to produce and use herbicides is the most effective way to avoid worse situation. Advanced mechanical weeding method can be developed to replace herbicides.

### 2 Proper setting up of window curtain

Indoors, the resistance of TPP in haze can lie in proper setting up the window curtain made by reticular cotton cloth (see appendix). Generally, the total area of widow curtain is several times over to times to those of window. So that, when the window curtain can be hanged on in wave pattern and cover the whole wall of the window. Certain distance to the wall must be kept, and the bottom of curtain must be close to ground. Curtain set in this method can let some part of the poisonous tiny powder descend and block by the curtain before the rest fresh air go through the curtain (Fig. 5).

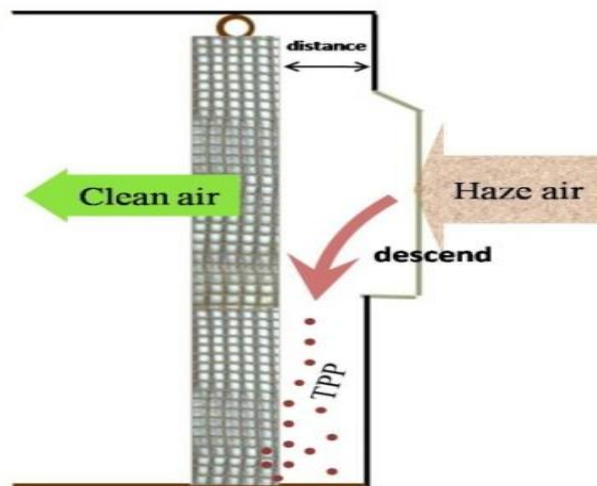


Fig. 5 Proper set up window curtain resistant TPP in haze.

### 3. Fighting against herbicides by burning firewood

Nearly all herbicides are composed of organic compound; hence the poisonous gas produced by spraying herbicides would decompose in high temperature.

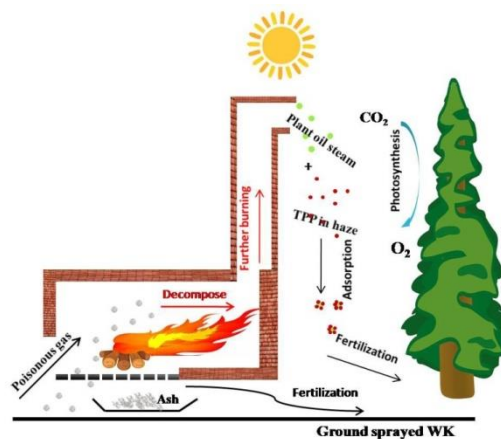


Fig.6 Elimination of poisonous gas and TPP in a burning box-shaped stove

Fig. 6 shows a typical burning box-shaped stove composed of a big chamber and a long chimney, which guarantee well burning and high temperature in the stove. This stove can be simplified to column-shaped stoves (see Fig. s1). Because of

chimney effect [19], when the firewood is burning in the chamber, air with poisonous gas would be imported from the ground surface below and thermally decomposed in the chamber; the long chimney will promote sufficient further burning, exhaust the burning gas upside and release it. The released burning gas usually contains high-temperature plant oil steam coming from the burning of firewood, which can absorb the TPP in haze and convert them to larger particles that will return to the ground and fertilized earth. It is observed that in haze weather, the air around the well burning stove is always found to be clearer than other locations. If the stove is set near trees, in sunny days, CO<sub>2</sub> in burning days can be well converted to O<sub>2</sub> through photosynthesis. Burning ash can also be good fertilizer for trees. Trees around the stove are typically glossy and green, their ability to purify air strengthens and their fruits are more fragrant and sweet. Additionally, promotion of the insect resistibility for plants is another function of burning firewood. Firstly, as the air is purified and vivifying woods gives useful animals which eat the pest such as birds and frogs suitable place to live so that the development of injurious insect will be suppressed. Secondly, as the growth of tree thrive, the natural insect resistibility for tree promoted.

#### **4. Transport the garbage to hills and burn in stoves**

Garbage here refers to domestic garbage produced by human life, animal waste and dead bodies. Many people in some regions are used to abandon the garbage directly into the nature such as lakes and rivers, making the water become more and more fertile but the soil on hills become more and more poor. "Fertile" lead to seawater eutrophication, "Poor" make the plant land lack of nutrition and grow frailty. Landfill is another way to dispose garbage. However, vast land is occupied where plants get hard to live and water area is polluted by landfill leakage.

The best solution is as follows: carry the garbage to hills where the offensive smell and garbage leakage can be absorbed by trees. After drying naturally, they can be burned in trash-burning stove built nearby, the heat can be used to generate electricity, and the furnaces dusts are good fertilizer for plants in the hill. Especially, waste oil and fat in garbage will create high-temperature oil steam after burning, which is effective in coping with haze. In this way air condition can be greatly improved in several years.

## **IV. CONCLUSION**

Six tests demonstrated imply the influence of spraying herbicide and its connection to haze. The reactive production of herbicide and soil and their connection to the formation of haze is put forward. Respiratory infectious disease is also presumed to connect to herbicide. Then, a method of setting up window curtain to block haze more effectively is also given. Typically, burning firewood and garbage in suitable stove near trees has been certified to be effective way to fight against herbicide and haze through decomposing poisonous gas in high temperature and absorption of TPP. The investigation provides totally new ideas about haze, the most compelling environmental problem in China and will be helpful to treat it.

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## APPENDIX - A

### *1. Cotton mosquito net cloth*

The cotton fiber and porosity in these cloth facilitate the absorbance of TPP in haze Window curtains, door screens composed of several layers of these cloth are effective to block air pollution and create clean air environment indoor. After used for a period of time, the window curtains or door screens need to be soak by boiling water and washed to get rid of TPP and recover their function.

## 2. Box stove

As shown in Figure 5, garbage and firewood is put in the stove chamber from one side. The volume of the furnace chamber is large and a long chimney is installed on the other side of stove. The material of the chamber and chimney must be heat retaining and incombustible. This type of stove will guarantee sufficient burning and high temperature in the chamber and prevent peculiar smell from burning daily garbage. The end of chimney had better to be set in the place with a draught which flows to trees.

## 3. Column-shaped stoves



**Fig. s1** the column-shaped stove

Compared to box stove, the column-shaped stove which is composed of several layers of bricks (see Fig. s1) is more convenient, flexible and occupies small area of ground. It can be easily built whenever or wherever need, but its capacity and burning efficiency is relatively inferior. For convenience, the height of this type of stove is about 1.5 meters, and the cross sections of these stoves are round or square. The burning firewood or garbage added from upside occupies about half space of the furnace chamber, and similar to box stove, the burning ash fall from downside through a stove tooth. Column-shaped stove is suitable to be used on the vacant ground in woods.