TROUBLE BREWING

Pesticide residues in tea samples from India

GREENPEACE
ग्रीनपीस

VIEW OF HARRISON MALAYALAM ESTATE, MUNNAR
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Report produced by Greenpeace India, August 2014

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EXECUTIVE SUMMARY

An investigation carried out by Greenpeace India has found residues of hazardous chemical pesticides in a majority of samples of the main brands of packaged tea produced and consumed in India. Over half of the samples contained pesticides that are 'unapproved' for use in tea cultivation or which were present in excess of recommended limits.

The results indicate that the cultivation of tea in India continues to rely on of the use of a diverse range of pesticides, consistent with previous analyses of pesticide residues in tea produced in India.[1] This dependency on pesticides is an inherent part of the current system of industrial agriculture and in the cultivation of tea in other countries, as shown in a similar report on Chinese tea published by Greenpeace in 2012.[2]

India is the second largest producer and the fourth largest exporter of tea globally, with the marketing and sales of tea forming a multi-billion dollar market (estimated at US$40.7 billion) both domestically, and globally. Within India, the top two brands – Hindustan Unilever Limited, subsidiary of the global multinational company Unilever, and Tata Global Beverages Limited – share upwards of 50 percent of the market.

A total of 49 branded and packaged teas were sampled. These were purchased between June 2013 and May 2014 from retail outlets in Mumbai, Bangalore, Delhi and Kolkata and were sent to an independent accredited laboratory to be tested for the presence of over 350 different pesticides. The samples cover eight of the top eleven companies[3] which dominate the branded tea market in India.

These include well-known brands produced by **Hindustan Unilever Limited, Tata Global Beverages Limited, Wagh Bakri Tea, Goodricke Tea, Twinings, Golden Tips, Kho-Cha and Girnar.**

KEY FINDINGS

- **A total of 34 pesticides were found, with 46 samples of branded tea – or 94% - containing residues of at least one pesticide.**
- **59% (29 of the samples) contained 'cocktails' of more than 10 different pesticides, including one sample which contained residues of 20 different pesticides.**
- **59% (29) of the samples also contained residues of at least one pesticide active ingredient above the Maximum Residue Levels set by the EU (EU-MRL), with 37% (18) of the tea samples exceeding these levels by more than 50%.**
- **The chaotic and conflicting state of regulations in India regarding authorisation of pesticides makes it extremely difficult to draw clear conclusions. However, 68% of the 34 pesticides found in the various samples appear not to be registered for use in cultivation of tea.**

PESTICIDE SPRAYING AT TATA'S PERIAKANAL ESTATE
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PESTICIDE SPRAYING AT TATA'S PERIAKANAL ESTATE
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SPECIFIC EXAMPLES INCLUDE:

MONOCROTOPHOS, *a suspected mutagen and neurotoxicant, found in 27 samples across tea brands made by various companies including Tata, Hindustan Unilever, Kho Cha, Royal Girnar, Goodricke, Wagh Bakri and Golden Tips. This pesticide is not approved for use on tea and is classified as Highly Hazardous (Class Ib) by the World Health Organisation*

TRIAZOPHOS, *another unapproved toxic pesticide, was found in five samples (in tea brands made by Tata, Hindustan Unilever, and Wagh Bakri). This pesticide is also classified as Highly Hazardous (Class Ib) by the World Health Organization (WHO).*

TEBUFENPYRAD, *which is not registered in India, and therefore illegal, was found in one sample manufactured by Hindustan Unilever. Tebufenpyrad is a potential liver toxicant at high concentrations.*

DDT, *The results also showed the presence of the pesticide DDT, banned for use in agriculture in India since 1989, as well as a significant number of pesticides classified as Moderately Hazardous according to WHO.*
These included Cypermethrin, classified as a respiratory irritant, and the neonicotinoid insecticide Imidacloprid has shown the potential to cause reproductive or developmental impacts in animals. All three of these pesticides were found in 60% or more of the samples.

NEONICOTINOID INSECTICIDES *were present in a large proportion of samples (for example, Thiacloprid at 67.3% and Thiamethoxam at 78%), which may indicate that these relatively new entrants to the agro-chemical market are becoming insecticides of choice in tea cultivation, and that tea production is still firmly stuck on the industrial pesticide treadmill.*

> *" India has already witnessed an agricultural movement without pesticides in the form of Non Pesticide Management methods, which have been initiated in Andhra Pradesh."*

> *"The tea industry needs to take responsibility for existing problems to make a commitment to their consumers that they can trust that tea production will not contaminate the environment or expose consumers to hazardous pesticide residues, from crop to cup."*

THE RESULTS indicate that the cultivation of tea in India continues to depend on a large number of chemicals with proven adverse effects on the environment and human health. Companies purchasing and selling tea in India and other key stakeholders in the industry need to act urgently to ensure the protection of the environment and of human health.

Such changes will require strong supportive policies to ensure the tea sector as a whole, including small tea growers, can shift rapidly away from the use of these chemical pesticides and thereby avoid the associated hazards and costs – to health, to the environment and to business reputations – that they incur.

India has already witnessed an agricultural movement without pesticides in the form of Non Pesticide Management methods, which have been initiated in Andhra Pradesh. These have the potential to be scaled up nationally and have proven to be both economically and ecologically viable.[4] The tea sector needs to become aware of ecological agriculture systems which already exist and to apply the same principles in tea cultivation.

Ecological agriculture techniques could prove to be both a sound business choice for the tea sector as well as a global market leadership opportunity for any given tea brand.

The tea industry needs to take responsibility for existing problems to make a commitment to their consumers that they can trust that tea production will not contaminate the environment or expose consumers to hazardous pesticide residues, from crop to cup.

INTRODUCTION
THE IMPORTANCE OF TEA IN INDIA

The tea industry in India is now over 175 years old, with the total area under tea cultivation around 9.8 lakh or nearly 1 million hectares. Tea is produced in plantations across the Northeast and Southern regions of India, mainly in the states of Assam, West Bengal, Tamil Nadu and Kerala, with the most intensively cultivated areas in the Northeast accounting for around three quarters of national production. Some 26% of the tea producing land is cultivated by small growers[5] on plots of less than 10.12 hectares (25 acres).

India is the second largest producer of tea in the world after China and the fourth largest exporter in the world after Kenya, China and Sri Lanka. Tea exports contribute to foreign exchange earnings. In addition, tea cultivation is also a source of revenue to the governments of the tea growing states and also to central government through VAT and various taxes. Total exports during 2011-12 amounted to some 214 million kg and the total foreign exchange earned during 2011-12 is estimated at Rs. 3305 Crores[6] Despite the importance of tea export earnings to the Indian economy, most of the tea produced is consumed within India. Of the total of 1.2 million tonnes produced in 2013, nearly 80% of production was consumed domestically.[7] These figures are broadly confirmed by other sources of market information.[8]

It has been estimated that the tea industry employs more than a million workers directly. Many of these workers are women. Over six million more people are estimated to derive their livelihood indirectly from the industry through ancillary activities.This includes a buoyant tourism element.[9]

Despite the importance of tea cultivation to the Indian economy, the sector has recently been facing a range of problems, which include the stagnation of tea production, climate change, habitat destruction, water pollution and soil erosion. These issues pose serious questions as to the long-term sustainability of the tea sector in India. Currently, the industry now appears to be finally recovering from an economic recession, which has affected the whole industry.

The cultivation of the tea plant *Camellia sinensis* is carried out as a monoculture, which, nonetheless, is known to provide habitat for at least 1,000 species of arthropods and 80 species of nematodes worldwide, some of which are considered ‘pests’ when their presence affects the health of the crop.

Overall, in Asia, 230 species of insects and mites have been identified as pests of tea. In Northeast India, 173 arthropod and 16 nematode pests have been identified and pest-related problems are regarded as particularly acute in Assam, a key tea producing area. Leaf, stem, root, flower and seed are all targets for pest attacks and these can cause losses of yield in the crop of at least 10-15%. As a result, a high per hectare application of pesticides is often employed in order to control these pests.[10]

The use of pesticides on agricultural produce can lead to residues of the active ingredients or their derivatives persisting in the environment, and in the harvested and processed commodities.

> *Tea is no exception and previous work published by Greenpeace in China, as well as reports from work carried out by organisations elsewhere, has identified the presence of pesticides in tea as a serious problem, which undermines its otherwise positive image as beneficial to health and well-being.[11] [12]*

In addition, there are potential consequences for international trade arising from the presence of such residues. Some countries and some international organisations, such as the Food and Agriculture Organisation (FAO) of the United Nations, and many countries that are important tea export markets for India – including Russia, the EU, USA and Canada - have established Maximum Residue Levels (MRLs) for pesticides in traded agricultural commodities.[13]

MANUAL WEEDING
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THIS DOCUMENT REPORTS THE DIFFERENT TYPES AND CONCENTRATIONS OF PESTICIDES FOUND IN SAMPLES OF TEA MARKETED FOR DOMESTIC CONSUMPTION BY A NUMBER OF MAJOR PRODUCERS AND BRAND LEADERS IN INDIA.

III TEA COMPANIES & TEA BRANDS

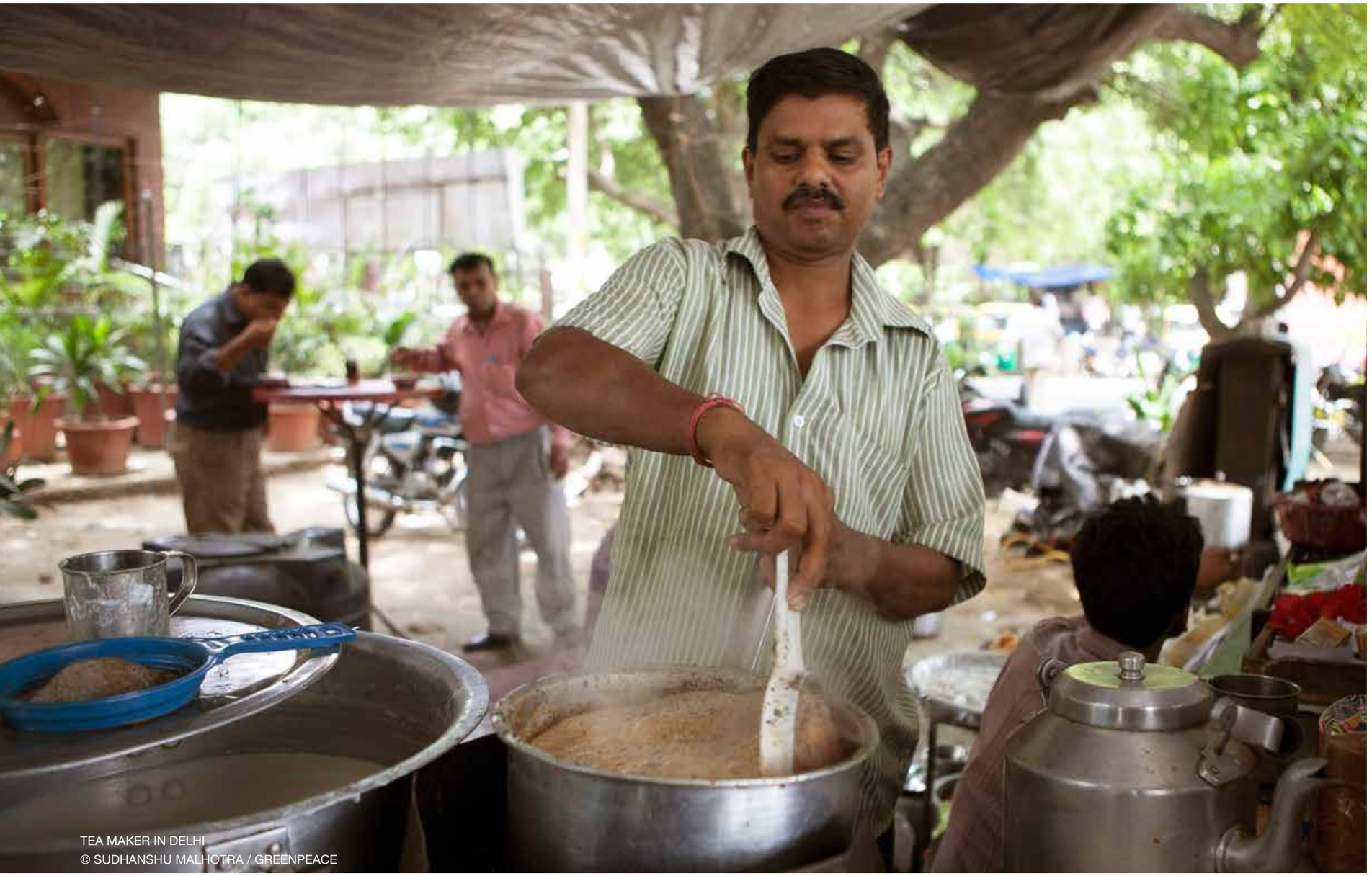
The tea market in India is made up of diverse national and international players. The dominant brands are marketed by Hindustan Unilever and Tata Global Beverages, which account for around 54% of the market, with brands marketed by Wagh Bakri and Duncan Industries accounting for a further 8.2%, as of 2012. A variety of other brands from diverse manufacturers account for the remaining 34% of the market[14], as shown in Figure 1. This report focuses on the brands sold by the top 11 companies according to their market share in 2012.

PIE CHART SHOWING OVERALL MARKET SHARE OF THE ELEVEN DOMINANT COMPANIES SELLING/ MARKETING TEA IN INDIA[15]

29%	HINDUSTAN UNILEVER LTD	1.5%	AMAR TEA PVT LTD
25%	TATA GLOBAL BEVERAGES LTD	1.4%	GOODRICKE GROUP LTD
5.6%	WAGH BAKRI LTD	1.3%	TWININGS PVT. LTD
3.1%	DUNCAN'S INDUSTRIES LTD	1.1%	GOLDEN TIPS TEA CO
1.8%	GIRNAR FOOD & BEVERAGES PVT. LTD	0.7%	MADHU JAYANTI INTERNATIONAL LTD
		0.2%	KHO-CHA DARJEELING TEA BUREAU
		26.6%	OTHER PRODUCERS

IV PESTICIDE TESTING

A SNAPSHOT OF INDIAN TEA BRANDS



TEA MAKER IN DELHI
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Samples of packaged tea were obtained from retail outlets in the cities of : Mumbai (13 samples), Bangalore (14 samples), Delhi (11 samples) and Kolkata (11 samples) on three occasions between June 2013 to May 2014.

Sampling was intended to broadly reflect the array of products available from the companies identified above, with the exception of Madhu Jayanti International Ltd. and Duncan's Teas, whose products are not represented as they were not available and Amar Tea Pvt. Ltd, which was a relative newcomer to the market and therefore not considered.

The samples represent a "snapshot" of teas available from retailers (and the results similarly provide a "snapshot" of the pesticides that they contain), rather than a fully systematic or exhaustive survey. A total of 49 samples of packaged tea were collected with some brands obtained in duplicate. Subsamples of the tea were then sent to an accredited laboratory for analysis using a multi-residue analysis method targeting 358 different pesticides.

V RESULTS

Nearly 94% (46 out of 49) of the tea samples contained residues of at least one of 34 pesticide active ingredients[i], at concentrations above the analytical limit of quantification (LOQ[ii]).

Some samples were also found to contain residues above the analytical limit of detection (LOD[iii]) but below the LOQ (unquantifiable 'trace' levels), but these are not considered further in this study. Nearly 60% (29 out of 49) of the samples contained residues of more than 10 different pesticides above their respective LOQ, including one sample that contained residues of 20 different active ingredients. For the full data, refer to Annex Table 3.

The most frequently detected pesticides Thiamethoxam, Cypermethrin, Acetamiprid, Thiacloprid, DDT, Deltamethrin, Dicofol (-p,p' isomer only), Imidacloprid and Monocrotophos, were present in over half of the samples DDT was detected at considerably lower concentrations than the other pesticides (see: Table 1; Annex, Table 2, 3)

THE MOST FREQUENTLY DETECTED PESTICIDES

PESTICIDE	Number of samples where pesticide was found above LOQ, out of 49, and percentage.	Range of concentration, mg/kg
THIAMETHOXAM	**38 = 78%**	**0.40 - 0.34**
CYPERMETHRIN	**36 = 73%**	**0.01 - 3.20**
ACETAMIPRID	**33 = 67%**	**0.01 - 0.32**
THIACLOPRID	**33 = 67%**	**0.02 - 0.80**

Note that the scope of sampling was based on previous market share data by Euromonitor International, Tea in India, 2012, which showed the leading tea brands as follows: (add list 1. Hindustan Unilever Ltd. (29.1%) 2. Tata Global Beverages Ltd. (25%) 3. Duncan's Industries Ltd. (8.3%) 4. Wagh Bakri Ltd. (3.6%) 5. Goodricke Group Ltd. (1.4%) 6. Twinings Pvt. Ltd. (1.3%) 7. Golden Tips Tea Co. Pvt. Ltd. (1.1%) 8. Girnar Food & Beverages Pvt. Ltd. (0.9 %) 9. Madhu Jayanti International Ltd. (0.7%) 10. Kho-Cha Darjeeling Tea Bureau (0.2%) 11. Private Label (2.6%) 12. Others (25.9%) Tea from all brands on this list was sampled, apart from Duncan's and Madhu Jayanti. Amar Tea is a new entrant in the Top 10 tea brands in 2012 (Euromonitor International 2013, op.cit).

Sampling over an extended time frame in each of the four cities was designed to ensure a broad representation of products on the market. To a certain degree, the number of samples from each company reflects their relative importance in the market. Similarly, the brands obtained from each of the cities do not fully reflect their relative availability in different regions of the country.

Loose (unpackaged) tea was not sampled and there was no sampling of fruit, floral or herbal infusions with or without added *Camellia sinensis.* In addition, no samples were included of tea "premixes" ready formulated with milk powder and sugar. After purchase, a sub-sample of 100g was taken from each package and placed in a polythene "Ziplok" bag or a pre-cleaned glass jar and allocated a unique sample number. This was intended to "anonymise" the samples prior to analysis. Annex I details the full list of pesticides targeted in the analysis. Analysis was carried out in three batches according to the date on which the samples were collected.

[i] Pesticide active ingredients are the chemicals in pesticide products that kill, control, or repel pests. Often, the active ingredients make up a small portion of the whole product.

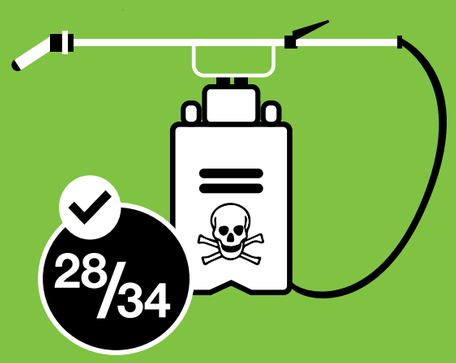
[ii] Limit of Quantification (LOQ) – the lowest concentration of a substance that can be reported in quantitative terms within acceptable bounds of error.

[iii] Limit of Detection (LOD) - the lowest concentration of a substance that can be distinguished from the absence of that substance, but which cannot necessarily be quantified.

PESTICIDE	Number of samples where pesticide was found above LOQ, out of 49, and percentage.	Range of concentration, mg/kg
DDT	**33 = 67%**	**0.005-0.044**
Deltamethrin	**33 = 67%**	**0.01-0.05**
Dicofol (-p,p' isomer only)	**30 = 61%**	**0.01-0.14**
Imidacloprid	**30 = 61%**	**0.01-0.14**
Monocrotophos	**27 = 55%**	**0.026-0.270**

Nearly 60% (29/49) of the samples contained residues of at least one active ingredient above the Maximum Residue Levels set by the EU (EU-MRL), with 37% (18) of the tea samples exceeding these levels by more than 50% (see full data in Table 4 in Annexes).

The most comprehensive listing of Maximum Residue Levels (MRLs) in commodities to date is that published by the European Commission[16], covering 528 separate pesticides and this is the listing used as the basis for comparison with the levels found in this study.



A total of between 28 and 34 pesticides are approved for use in tea cultivation in India (see Box 2) as noted in various source documents.

In India, however, MRLs are set for only 7 pesticides in tea. These form a small proportion of the pesticides found in this study and of the pesticides registered for use in India on tea[17]. Of those registered in India for tea production, Quinalphos was found in two samples at levels of 0.02 and 0.026 mg/kg, in excess of the Indian MRL of 0.01 mg/kg, but well below the EU-MRL of 0.1 mg/kg.

The following section gives some examples of unregistered (illegal) and unapproved pesticides that were found in the tea samples.

MORE SPECIFICALLY

Of the 33 samples found to contain residues of Acetamiprid above the LOQ, concentrations were above the EU-MRL in 21 samples, with 11 samples exceeding this limit by more than 50%.

Concentrations of Monocrotophos exceeded the EU-MRL in 10 out of the 27 samples in which this pesticide was detected above the LOQ, with 5 samples exceeding this limit by more than 50%.

One sample contained concentrations of Tebufenpyrad at over 10 times the EU-MRL.

TABLE 1 **THE NUMBER AND RANGE OF PESTICIDE RESIDUES DETECTED SHOWN BY BRAND**

COMPANY	BRAND	NUMBER OF SAMPLES	NUMBER OF PESTICIDES DETECTED
Hindustan Unilever Limited (HUL)	*Brooke Bond*	7	12-20
Golden Tips Tea Co. Pvt. Ltd.	*Golden Tips*	3	1-7
Goodricke Group Ltd.	*Goodricke*	4	2-19
Tata Global Beverages Ltd	*Kanan Devan*	1	16
Kho-Cha Darjeeling Tea Bureau	*Kho-cha*	3	1-13
Hindustan Unilever Limited (HUL)	*Lipton*	7	1-16
Girnar Food and Beverages Pvt. Ltd	*Royal Girnar Cup*	1	13
Tata Global Beverages Ltd	*Tata Tea*	8	11-15
Tata Global Beverages Ltd	*Tetley*	3	0-14
Twinings Pvt. Ltd	*Twinings*	8	0-11
Wagh Bakri Tea	*Wagh Bakri*	4	13-16

(A full list of the pesticides analysed and the number of residues found per tea brand can be found in the Annex (Table 2).

FAILURE AND CONFUSION IN THE REGULATION OF PESTICIDES IN INDIA

The regulation of pesticides in India is complicated and confusing. The responsible authority for registering pesticides for use on crops to control pests and weeds is the Central Insecticides Board and Registration Committee (CIBRC), which falls under the Ministry of Agriculture (MoA).

As of May 2014, a total 248 chemical pesticides have been registered under section 9(3) of the Insecticides Act (1968) for use in India, for all crops. However, the rationale for permitting these remains far from clear; for example, the list contains Endosulfan, which has been subject to a separate comprehensive ban by decision of the High Court as of 2011[18].

There are also inconsistencies between different documents published by the CIBRC; its list of approved formulations contains only 241 approved formulations of single active ingredients (compared to the 248 registered, mentioned above), which are listed together with 33 combined formulations of insecticides, 24 combined formulations of fungicides, 14 combinations of herbicides and 1 combined insecticide/fungicide[19]. In addition, pesticides are also regulated by the Food Safety and Standards Authority of India (FSSAI), part of the Ministry of Health and Family Welfare (MoHFW), which is responsible for setting tolerable residues of contaminants in foodstuffs under the Food Safety and Standards (Contaminants, Toxins and Residues) Regulations 2011.[20]

After registration, pesticides can be recommended by the State Agricultural Universities (SAUs) and other boards and research institutions. Examples of such bodies include the Tea Board and Tea Research Association.

Inexplicably, in the case of tea, some agricultural universities and government boards have recommended the use of pesticides that have not been approved for use on tea plantations by the CIBRC. With such a diversity of bodies making different recommendations on the use and application of pesticides, including pesticide-marketing agencies, the potential for confusion and consequent overuse or misuse of pesticides is high. Furthermore, the Food Safety and Standards (Contaminants, Toxins and Residues) Regulations, 2011 specifies tolerance limits in tea for only 7 of the pesticides registered for use on tea.

The numbers of pesticides commonly listed as actually registered by the CIBRC for use in tea cultivation varies between 28 and 34, with some variations between those included in each list. For example, the Centre for Science and Environment in New Delhi lists 28 separate active agents[21] registered by the CIBRC for use in tea crops, but points out that there are considerable inconsistencies between those registered by this central body and those recommended for use by universities and other research establishments on behalf of individual states. Many pesticides registered for tea are not recommended for use by state bodies. More seriously, many of the pesticides (up to 10 in Assam) recommended by state bodies are not registered by CIBRC for tea crops.

This confusing situation extends to peer-reviewed publications on the subject. A 2011 publication lists 30 active ingredients[22], whereas a 2008 paper lists 27 formulations and differs again in detail from the other two lists.[23]

With such a diversity of bodies making different recommendations on the use and application of pesticides, including pesticide-marketing agencies, the potential for confusion and consequent overuse or misuse of pesticides is high. Furthermore, the Food Safety and Standards (Contaminants, Toxins and Residues) Regulations, 2011 specifies tolerance limits in tea for only 7 of the pesticides registered for use on tea.

Many pesticides registered for tea are not recommended for use by state bodies. More seriously, many of the pesticides (up to 10 in Assam) recommended by state bodies are not registered by CIBRC for tea crops.

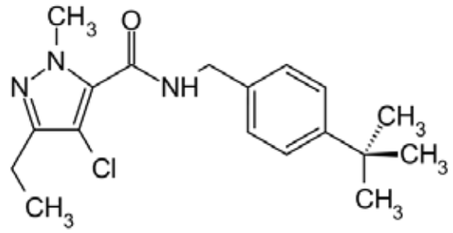
The Tea Board of India, as part of its published Plant Protection Code, lists 32 formulations as approved for use on tea, comprising 26 individual active ingredients.[24] This again differs in detail from the approved uses of registered pesticides published by the government[25], which contains 33 active agents (including the banned Endosulfan, the Class Ib pesticide Carbofuran and the unlisted Flumite). The inconsistencies between central registration, even between the CIBRC and the Tea Board (both government bodies), as well as differing regional recommendations, may go some way to explain the presence of unregistered pesticides in the tea samples.

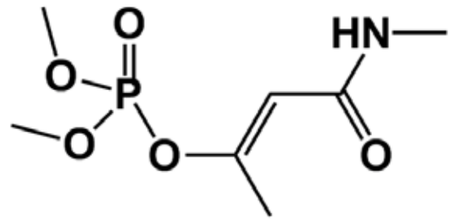
There is a clear indication that the regulatory system is in crisis and that there are some serious flaws, which need to be fixed. This cannot be achieved by adopting a reductionist or piecemeal approach, which looks at banning a few active ingredients; instead, policy and regulation needs to be based on the Precautionary Principle*. Moreover, rather than investing in an expensive system to check for agro-chemicals, tea companies should invest the same financial resources in non-pesticide solutions, which are ecologically, economically and socially viable alternatives to chemical pesticides.

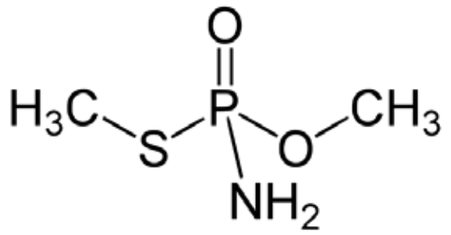
* *This means taking preventive action where there are legitimate reasons for concern regarding the intrinsic hazards of a chemical, even if information is insufficient to verify those hazards. It is based, in part, on the premise that some hazardous substances cannot be rendered harmless by the receiving environment (i.e. there are no 'environmentally acceptable'/ 'safe' use or discharge levels) and that prevention of potential damage is required.The process of applying the Precautionary Principle must involve an examination of the full range of alternatives, including, where necessary, substitution through the development of sustainable alternatives where they do not already exist.*

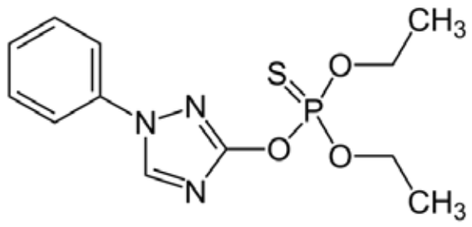
VI ILLEGAL AND UNAPPROVED PESTICIDES IN USE

STILL STUCK ON THE PESTICIDE TREADMILL









ILLEGAL! **TEBUFENPYRAD**

Despite the complex regulatory background, the results indicate the definitive illegal use of at least one pesticide, Tebufenpyrad (a pyrazole miticide/ insecticide), that does not appear to have even been registered in India. This active substance was found in one sample of tea.

UNAPPROVED! **MONOCROTOPHOS**

A WHO Class Ib pesticide, has been registered in India by the CIBRC, but has not been permitted for use on tea at government level. The Tea Board List of Approved Plant Protection Formulations explicitly excludes all WHO Class Ia and Ib chemicals from use on tea. It is important to note that while this list was introduced in March 2014, Monocrotophos was not permitted on any previous versions of the list.

Given its low to moderate environmental persistence, the fact that Monocrotophos was found in 27 samples, with concentrations in 10 of these in excess of EU-MRLs, shows its probable ongoing use in tea cultivation. As its Class Ib designation suggests, it is highly toxic to humans and other mammals, as well as being a suspected mutagen, neurotoxicant and skin irritant (According to the International Union of Pure and Applied Chemistry (IUPAC) database)

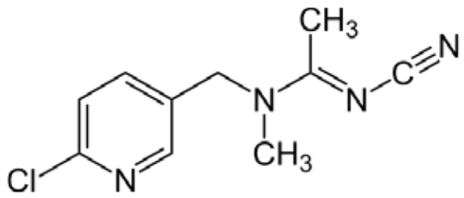
METHAMIDOPHOS

Methamidophos, which was found in 2 samples of tea, is also a WHO Class Ib pesticide and is not registered for any use in India. It is highly toxic to humans and is a suspected mutagen and neurotoxicant, like Monocrotophos. As it is a degradation product of the insecticide Acephate, its presence may not be due to primary illegal use. Nevertheless, Acephate is not approved for use on tea crops either.

TRIAZOPHOS

The organophosphate Triazophos, found in 5 samples, is also a WHO Class Ib pesticide and was found at levels exceeding EU-MRLs. It is also not approved for use on tea in India, although it is registered.

Of the neonicotinoid insecticides detected in the samples, only Thiacloprid and Thiamethoxam are registered for use on tea. These were present in 67% and 78% of samples respectively, which may indicate that these relatively new entrants to the agro-chemical market are becoming insecticides of choice in tea cultivation. Nonetheless, several neonicotinoids that are not approved for use on tea in India were detected:

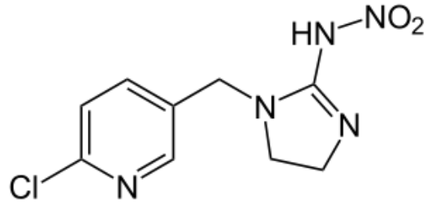


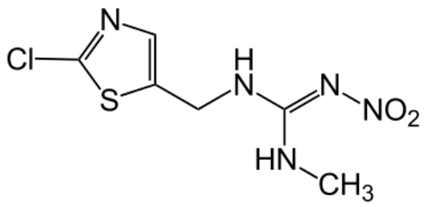
ACETAMIPRID

in 67% of samples, in many cases exceeding EU-MRL values, suggesting that the unapproved use of this insecticide in tea cultivation may be widespread.

IMIDACLOPRID

in 61% of samples although the proportion of MRL breaches was lower than for Acetamiprid.





CLOTHIANIDIN

in 20 samples. However, as Clothianidin is known to be a metabolite of the registered pesticide Thiamethoxam, it is not clear whether degradation of Thiamethoxam is responsible for the Clothianidin residues found in this study or whether they are present due to its direct (and unapproved) use as an active agent.

The synthetic pyrethroids Cypermethrin and Deltamethrin were also detected in a large proportion of tea samples (73% and 65% of samples respectively), suggesting possible use on tea of these unapproved pesticides.

OTHER CONCERNS

ANTHRAQUINONE *was found in 4 samples, despite not appearing on the Indian CIBRC list of registered products.[26] Accordingly, its use as a pesticide in India is illegal. However, an alternative explanation for the presence of Anthraquinone in the samples is that it may be due to its use in paper and card manufacture and its subsequent migration from packaging to the tea. This has led some agencies in other countries to recommend that Anthraquinone should not be used in the manufacture of paper used in food contact applications.[27]*

ETHION, *another organophosphate, is a metabolite of the unapproved pesticide Chlormephos, its presence in 22 of the tea samples is most likely due to its direct use on tea since Ethion is approved in India for use as an acaricide (Acaricides are pesticides that kill members of the arachnid subclass Acari, which includes ticks and mites) on this crop.*

DDT. *The presence of DDT in 67% of the tea samples is intriguing since it is no longer registered for use in agriculture in India and was banned in such applications as long ago as 1989. Nonetheless, it is still allowed for use in malaria as a vector control in India in quantities of up to 10,000 metric tons per annum and is particularly used in the North- Eastern States and hilly regions of the country.[28] In fact, actual usage appears to be much lower, at around 3200 tonnes in 2007,[29] although recent estimates of use vary between sources. Widespread resistance of mosquitos to DDT and to other pesticides has been reported in India.[30]*

Continued use of DDT as a vector control may explain the presence of DDT residues in the samples, further supported by the relatively low prevalence of DDE, a major degradation product of DDT. The possibility that unapproved use on tea may have also contributed to the levels found cannot, however, be ruled out. Indeed, the analysis of surface soils from the Northeast India for several organochlorine pesticides has suggested contemporary use of DDT in tea plantations in the region.[31]

Another possibility is that DDT is present as a contaminant of the acaricide Dicofol, which is approved for use on tea as a miticide (miticides are used to control mites or ticks) and which was detected in 61% of samples (in the form of its predominant p-p' isomer). DDT is used as the raw material to synthesise this chemical[32] and DDT residues may be carried through to the final product in significant quantities.

ENDOSULFAN *was banned for production, use and sale throughout India following a decision of the Supreme Court in 2011, although it is currently still listed as registered by the CIBRC.[33] Prior to the ban, India was one of the world's largest producers and users of this pesticide, resulting in widespread environmental contamination, particularly due to its easy transport through the atmosphere. Accordingly, historical use and contamination, as well as some level of continued illegal use, could explain the presence of Endosulfan in around 8% of the tea samples analysed in the current study.*

FARMER WITH PESTICIDE SPRAYING EQUIPMENT
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Overall, 68% of the 34 pesticides detected in this study are not currently registered for use on tea by the CIBRC, while some have nonetheless appeared on lists of pesticides recommended for use on tea at the state level, exposing the possible impact of inconsistent regulations or recommendations at the regional and national levels.[34] Of these 'unregistered' pesticides found, three of the organophosphorus pesticides are classified by WHO as Class Ib (Highly Hazardous) pesticides; 20 pesticides are classified as Class II (Moderately Hazardous) while five are considered as WHO Class III (Slightly Hazardous). Three are classified as Class U (unlikely to present acute hazard under normal use), while a further three are not listed under the classification scheme.

A complete list of pesticides found in tea samples that are not approved by the CIBRC or the Tea Board for use in tea cultivation, together with the brands of tea in which they were found, is in the Annex, Table 4, with the registration and approval status of the pesticides found in Table 3.The results of the work reported here are consistent with other studies where a number of pesticides have commonly been found in tea samples. For example, a recently published study involving extensive sampling throughout South India revealed the common presence of a number of pesticide residues (Ethion, Quinalphos, Hexaconazole, Dicofol, Propargite and Fenpropathrin) in the samples.[35] A study from the Northeast of India (West Bengal) tested not only fresh leaves, but also brewed tea, soil samples and samples from watercourses in two regions. In one region (Dooars), organophosphates were detected in 100% of the samples, with the organochlorines **HEPTACHLOR** and **CHLORPYRIPHOS** exceeding MRLs in many samples. These two substances have been banned for use in tea growing in India.[36]

KEY CONCERNS

FIRSTLY, *many of the pesticides detected in the samples are not permitted for use on tea in India, raising questions about their origin in the samples and the legality of their use in tea cultivation.*

SECONDLY, *the presence of a variety of pesticide residues in a significant proportion of the samples demonstrates that pesticides are commonly present in the product as a mixture, which creates considerable regulatory challenges.*

FINALLY, *the use of such a wide range of pesticides raises significant questions about safety for pesticide applicators and other workers in tea cultivation and the possible impacts upon their health, as well as impacts on non-target organisms, on water and soil quality and on the wider environment.*

These results strongly suggest that the number of pesticides in use in tea cultivation is still large, with evidence that the older persistent pesticides such as DDT and Endosulfan are mostly being substituted by other pesticide groups, such as the pyrethroids and the more recently developed neonicotinoids. Tea is still clearly stuck on the "pesticide treadmill".

VII FROM CROP TO CUP

The fact that a variety of pesticides continue to be used in tea cultivation and that many of the samples contained a mixture of pesticides, raises questions about their impact on human health and the environment, from the exposure of workers during cultivation to the consumption of tea by consumers.

IMPACT OF PESTICIDES

FROM LOW DOSES AND CHRONIC EFFECTS

A number of studies have shown that some proportion of the pesticide residues contained in tea leaves can, depending on their water solubility, be extracted into the beverage through the infusion ("brewing") process. [37] [38] Given the presence of complex mixtures of residues in many of the tea samples analysed in the current study, there is clearly some potential for the consumption of brewed tea to contribute to overall pesticide exposures of consumers, though only as one component of dietary sources.

A recent report from the UN Food and Agriculture Organisation's Intergovernmental Group on Tea[39] provides 'brew factors' for a range of pesticides in both black and green tea, noting that the more water-soluble active ingredients (including Thiamethoxam, Thiacloprid, Imidacloprid and Monocrotophos, all frequently found in the analysis of tea samples reported here) are relatively easily extracted into the brewed tea. It is not possible from our data to estimate the likelihood and extent of pesticide extraction through infusion of the tea samples analysed, or, therefore, the potential significance of tea drinking as a contribution to mixed pesticide exposures in consumers.

Nevertheless, the recent FAO report cited above illustrates the seriousness with which potential impacts are being taken by competent bodies at an international level. Long-term potential health effects, which could take place at low levels of exposure to some pesticide active ingredients include endocrine disruption, reproductive and developmental effects, neuro-behavioural impacts, carcinogenesis and impacts on the immune system. These have been identified through animal testing and epidemiological studies.

Overall, very little is known about the chronic toxicity of many pesticides.

Even less is known about the impacts of pesticides upon consumers who are generally exposed to low levels of pesticides, but are exposed over long periods of time. In addition to the possible concerns about the effects of long-term low level exposure to pesticides present in food, population exposure tends to be in the form of mixtures of active agents.

The toxicology of such mixtures is very poorly understood. The pesticides present in tea are present as a mixture of active agents, with a diverse range of chemical and toxicological properties, meaning that detection of any effects at the individual or population level is extremely challenging.

HIGH DOSES AND ACUTE EFFECTS

Table 5 in the Annex shows a compilation of human health data taken from the IUPAC "Footprint" database. For the most part, these identified impacts will be based upon studies of individual active pesticide agents in acute poisoning incidents affecting agricultural workers and other unusually exposed population groups as well as upon laboratory animal studies. Acute poisoning incidents can happen when pesticides are ingested through the mouth, inhaled, or absorbed through skin contact.

It has been estimated[40] that globally there are between one and five million pesticide poisonings each year resulting in some 20,000 fatalities among agricultural workers.

The total health impact of pesticide use is likely to be much wider and more complex since the impact of long-term lower level exposure is much more poorly documented. There may be a time lag between exposure and the manifestation of diseases such as cancer. In addition, the precise impacts will depend upon the nature of the chemical concerned and as well as the dose characteristics. The overall health and nutritional status of those exposed may also affect the outcome of pesticide exposure, both acute and chronic.

COCKTAIL EFFECT OF PESTICIDE MIXTURES

The regulation and permitting of pesticides is generally focussed on individual active substances, on the basis of their toxicological properties considered with respect to a few selected test organisms.[41] Regulatory measures are then put in place with a view to managing and mitigating the perceived risks. Such systems are not able fully to take proper account of what happens in the environment, where pesticides tend to be present as mixtures, as shown by the results reported here for tea.

Although the presence of exposure to pesticide residues as mixtures is, therefore, a widely recognised phenomenon, there is currently no internationally accepted procedure for evaluating the effects of cumulative exposure from a number of pesticides simultaneously.[42] When neglected or not taken into account, this can result in an underestimation of exposure risk.

The combined actions of a suite of chemicals are sometimes described in terms of dose additivity, in that each of the chemicals contributes to a common impact but does not interact, or interfere, with the other chemicals. By contrast, where chemicals interact in some way, the combined effect of this will be either stronger (synergism) or weaker (antagonism) than predicted through an additive model.[43] There is growing evidence that components of the mixtures of chemicals found in this and in other studies may be capable of interacting in just such a synergistic manner.[44]

Understanding the mixture effects of pesticide cocktails is critical and considerable effort has been made to construct models to describe them.[45] [46] Despite such efforts, however, the ability of the models to accommodate the full complexity of a given mixture is highly limited and, accordingly, the effects of toxicant mixtures remain poorly characterised.

There are considerable inconsistencies in the patterns of biochemical responses of organisms exposed to chemical cocktails and it can therefore be difficult to identify and characterise their effects.[47] [48] Interactions of this kind between fungicides and insecticides in experiments using aquatic test organisms have been reported, while synergistic reactions have also been reported between fungicides and acaricides in tests on bees.[49]

In humans, it has been suggested that a person-orientated approach be taken so as to take into account the cumulative exposure to particular pesticides.[50] In addition, the relative contributions of a single compound present in a mixture may differ between individuals, making comparisons even more difficult.

There have been a number of studies that have used experimental methods to show that mixtures of pesticides can disrupt gene expression in some organisms.[51] [52] This disruption has the effect of altering some basic metabolic functions throughout the organism and this effect can be organ-specific.[53]

> *There is some emerging evidence that pesticide exposure may be associated with reproductive abnormalities, immune suppression, cancer and hormone disruption in humans, presumably as a result of changes in basic metabolic function.[54] Even in low concentrations, pesticide mixture effects can lead to differing and sometimes lethal impacts on some species of wildlife.[55]*

THE DAILY TEA
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FARMER WITH PESTICIDE SPRAYING EQUIPMENT
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TEA CONSUMERS
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TEA WORKERS EXPOSED

In Indian tea plantations, exposure of plantation workers to pesticide mixtures has been shown to induce DNA damage in the form of increased levels of micronuclei, indicating genotoxic effects.[56] The subjects of this study were exclusively female, who are traditionally not involved in spraying of crops, and their exposure was thought to be through proximity to adjacent areas of spraying and exposure to residual chemicals subsequent to spraying. Similar genotoxic effects have been described in workers exposed to pesticide mixtures in Italy[57] and Brazil.[58]

A study conducted by the National Labour Institute in 2012 revealed that around 5% of workers on tea plantations are engaged in pest control.[59] Further anecdotal evidence from interviews with 426 pesticides sprayers conducted by staff at the National Labour Institute, suggests that workers experience many forms of ailments and physical discomforts, primarily muscle and body aches (57%), feelings of weakness (49%), headaches (32%), chest pains (23%), respiratory problems (16%) and eye irritations (15%). Many workers experienced many problems simultaneously.

These sorts of effects are of particular concern in a country such as India in which the majority of workers are engaged in agriculture.

“ Anecdotal evidence from interviews with 426 pesticides sprayers conducted by staff at the National Labour Institute, suggests that workers experience many forms of ailments and physical discomforts, primarily muscle and body aches (57%), feelings of weakness (49%), headaches (32%), chest pains (23%), respiratory problems (16%) and eye irritations (15%).”

IMPACTS ON CONSUMERS ALMOST IMPOSSIBLE TO EVALUATE

Detecting potential health impacts from chronic exposure to a mixture of pesticides by consumers through dietary intake remains extremely challenging if not entirely impossible. Taking the current results as an example, it is clear that exposure is in the form of a mixture of diverse chemical types. The interactions between the chemicals are very largely unknown since the toxicology of such mixtures has rarely been investigated beyond simple binary mixtures of agents.

Assuming that of the 34 pesticides identified in this analysis, groups of 10 were selected for study as mixtures, then this would necessitate the evaluation of over 131 million different possible combinations. Even if combinations of only 2 were selected, then 561 different possible combinations would need to be taken into account.

Clearly, it is very unlikely that evaluations of all possible combinations will ever be carried out, indicating the need for an alternative approach, focused on avoiding the use of and exposure to pesticides wherever possible

“ The interactions between the chemicals are very largely unknown since the toxicology of such mixtures has rarely been investigated beyond simple binary mixtures of agents.

Assuming that of the 34 pesticides identified in this analysis, groups of 10 were selected for study as mixtures, then this would necessitate the evaluation of over 131 million different possible combinations.”

CONCLUSIONS AND GREENPEACE RECOMMENDATIONS

The results from this study demonstrate that branded tea purchased in India is broadly contaminated with a wide variety of pesticides. 59% of the samples contained 'cocktails' of pesticide residues of more than 10 different substances, including one sample which contained residues of as many as 20 different pesticides, pointing to the continued dependency of tea cultivation on a high number of chemicals.

Some pesticides were present at levels above the limits (MRLs) specified for tea in the EU and in India. A significant proportion of pesticides found are not approved for use in tea cultivation in India and many are no longer approved for use in the EU, a key export market.

Some of these unapproved pesticides are classified as Highly Hazardous by the WHO, including Monocrotophos, a suspected mutagen and neurotoxicant, found in samples across almost all tea brands, and Triazophos, suspected as toxic to most major organs, which was found in five samples. The chaotic and conflicting state of regulations in India concerning the registration and authorisation of pesticides makes it extremely difficult to draw clear conclusions.

However, over half of the 34 pesticides found across the samples appear not to be registered for use in the cultivation of tea. The wide range of unauthorised pesticides found is also likely to increase the difficulty and costs of testing and controlling for pesticide residues.

Neonicotinoid insecticides were present in a particularly high number of samples (Thiacloprid and Thiamethoxam were found in 67% and 78% of samples respectively), which may indicate that these relatively new entrants to the agro-chemical market are becoming the insecticides of choice in tea cultivation, indicating that tea production is still firmly stuck on the industrial pesticide treadmill.

CONVERSATIONS OVER TEA
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While the individual pesticide residues were present at levels well below those capable of causing acute toxicity, the potential impacts of chronic exposure to the mixtures of active ingredients that were isolated has not been, and probably cannot be, fully understood. The precise contribution of pesticides in tea to overall dietary exposure of consumers to pesticides has not been fully evaluated, while the large number of potential combinations of pesticides potentially requiring evaluation means that this is unlikely to be feasible.

However, chronic pesticide exposure could have potential long-term health impacts. The inability to model and evaluate the potential impacts of mixtures, including synergistic impacts of pesticides, as well as the potential health effects on tea farming workers from exposure to these pesticides, makes a strong case for exercising precaution to ensure avoidance of any exposure.

This makes a strong, legitimate and urgent case for the various commercial players in the tea sector to invest in a transition towards ecological approaches to cultivation in the tea sector and for the Government to set up relevant policy initiatives.

The case of West Jalinga tea estate situated in lower Assam by Inhana Biosciences suggests that an adoption of an integrated and holistic ecological approach in tea can lead to economic and ecological sustainability. These ecological concepts should not be confused with those that are currently promoted such as Integrated Pest Management (IPM) and should be seen as an essential part of the transformation of the Indian tea sector towards Ecological Agriculture.

ECOLOGICAL AGRICULTURE (EA) is used to here to mean farming (in this case tea farming) that relies on and protects nature by making use of natural ecosystem functions and agro-biodiversity integrating these into agro-ecological systems that ensure agricultural resilience, food security and food sovereignty and sustainable farmer livelihoods.

HAND PLUCKING LEAVES
© VIVEK M / GREENPEACE

TO SUPPORT THIS TRANSFORMATION OF THE TEA SECTOR TO ECOLOGICAL AGRICULTURE,

Greenpeace calls on companies purchasing and selling tea to urgently take the following steps:

1 To recognise that synthetic chemical pesticides are problematic and there is a need to adopt an area-based approach to progressively phase out pesticides in tea cultivation throughout India, as a first step towards Ecological Agriculture.

2 Ensuring greater transparency of products back to estate level. This should begin with a disclosure of the names and locations of plantations from which marketed tea is obtained.

3 Develop and invest in a road map along with appropriate stakeholders to gradually phase out pesticides in supply chain. This can begin with pilots on a large scale as the first concrete step.

4 Liaise with relevant government bodies to develop support systems for small tea growers to move away from pesticides, whilst maintaining their market access giving equal priority to tea in all major tea growing states.

V ANNEXES

Table 2: Pesticides by tea brand showing number of pesticides detected in each sample.

Table 3: Information on registration and approval status of the pesticides detected in tea samples

Table 4: List of pesticides found in tea samples that are not approved by CIBRC or the Tea Board for use in tea cultivation shown together with the brands of tea in which they were found.

Table 5: Data from the IUPAC Footprint pesticide database for stated human health impacts of pesticides detected in this study.

TABLE 2
PESTICIDES BY TEA BRAND SHOWING NUMBER OF PESTICIDES DETECTED IN EACH SAMPLE

PRODUCT	NUMBER OF PESTICIDES DETECTED
Brooke Bond Red Label Natural Care	12
Brooke Bond 3 Roses Natural Care	14
Brooke Bond Red Label	20
Brooke Bond Red Label	16
Brooke Bond Red Label Special	14
Brooke Bond Taj Mahal	14
Golden Tips Nilgiri Tea	1
Golden Tips Pure Darjeeling Tea	4
Goldentips Assam Tea	7
Goodricke Chai Strong CTC Long Leaf	19
Goodricke Roasted Darjeeling – Orange Pekoe	2
Goodricke Thurbo Flavoury Darjeeling Tea	2
Goodricke Thurbo Flavoury Darjeeling Tea	3
Kanan Devan	16
Kho Cha Darjeeling	1
Kho Cha Masala Chai	11
Kho-Cha Masala Chai	13
Lipton Clear Green Tea	1
Lipton Clear Green Tea	3
Lipton Darjeeling Tea	2
Lipton Yellow Label Tea	11
Lipton Yellow Label Tea	13
Lipton Yellow Label Tea	16
Lipton Yellow Label Tea	9
Red Label Natural Care	16
Royal Girnar Cup Tea	13
Tata Tea Gold	15
Tata Tea Gold	11
Tata Tea Gold	11
Tata Tea Gold	11
Tata Tea Life	11
Tata Tea Premium	14
Tata Tea Premium	12
Tata Tea Premium	13
Tetley Long Leaf Green Tea	6
Tetley Longleaf Green Tea	0
Tetley with Elaichi	14
Twinings Classsic Assam Tea	11
Twinings Classsic Lady Grey	9
Twinings Darjeeling Tea	1
Twinings Earl Grey	9
Twinings English Breakfast	9
Twinings English Breakfast	10
Twinings Green Tea	0
Twinings Green Tea and Lemon	0
Wagh Bakri Good Morning Tea	16
Wagh Bakri Perfect Premium Leaf Tea	14
Wagh Bakri Strong & Refreshing Premium Leaf Tea	13
Wagh Bakri Strong and Refreshing Premium Leaf Tea	14

TABLE 3

INFORMATION ON REGISTRATION AND APPROVAL STATUS OF THE PESTICIDES DETECTED IN TEA SAMPLES

PESTICIDES FOUND	CLASS AND TYPE 1	Frequency of detection	Registered for use in India? [2]	Registered for use on tea [3]	Approved in EU? [1]	WHO Class [4]
ACEPHATE	*Organophosphate Insecticide*	11	✓	✗	✗	III
ACETAMIPRID	*Neonicontinoid Insecticide*	33	✓	✗	✓	Not listed
ANTHRAQUINONE	*Unclassified*	4	✗	✗	✗	U
BIFENTHRIN	*Pyrethroid Insecticide/Acaricide*	21	✓	✓	✓	II
CARBENDAZIM	*Benzimidazole Fungicide*	6	✓	✗	✓	U
CHLORPYRIFOS (-ETHYL)	*Organophosphate Insecticide/Acaricide*	2	✓	✗	✓	II
CHLORPYRIFOS (-METHYL)	*Organophosphate Insecticide*	1	✓	✗	✓	II
CLOTHIANIDIN	*Neoniconitoid Insecticide*	19	✓	✗	✓	Not listed
CYFLUTHRIN	*Pyrethroid Insecticide*	2	✓	✗	✓	II
CYHALOTHRIN LAMBDA	*Pyrethroid Insecticide*	19	✓	✗	✓	II
CYPERMETHRIN	*Pyrethroid Insecticide*	36	✓	✗	✓	II
DDT	*Organochlorine Insecticide*	33	✓ (vector control)	✗	✗	II
DELTAMETHRIN	*Pyrethroid Insecticide*	32	✓	✗	✓	II
DICOFOL	*Organochlorine Acaricide*	30	✓	✓	✗	III
ENDOSULFAN	*Organochlorine Insecticide/Acaricide*	4	✓ (use banned)	✗	✗	II
ETHION	*Organophosphate Insecticide/Acaricide*	22	✓	✓	✗	II
FENAZAQUIN	*Quinazoline Insecticide/Acaricide*	8	✓	✓	✓	II
FENPROPATHRIN	*Pyrethroid Insecticide /Acaricide*	9	✓	✓	✗	II
FENPYROXIMATE	*Pyrazole Acaricide /Insecticide*	7	✓	✓	✓	II
FIPRONIL	*Phenylpyrazole Insecticide*	1	✓	✗	✓	II
FENVALERATE	*Pyrethroid Insecticide/Acaricide*	9	✓	✗	✗	II
HEXACONAZOLE	*Triazole Fungicide /wood preserver*	2	✓	✓	✗	U
IMIDACLOPRID	*Neoniconitoid Insecticide*	30	✓	✗	✓	II
METHAMIDOPHOS	*Organophosphate Insecticide/Acaricide*	2	✗	✗	✗	Ib
MONOCROTOPHOS	*Organophosphate*	27	✓	✗	✗	Ib
MYCLOBUTANIL	*Triazole Fungicide*	1	✓	✗	✓	III
PERMETHRIN	*Pyrethroid Insecticide*	4	✓	✗	✗	II
PROFENOFOS	*Organophosphate Insecticide/Acaricide*	3	✓	✗	✗	II
PROPARGITE	*Sulfite ester Acaricide*	20	✓	✓	✗	III
QUINALPHOS	*Organophosphate Insecticide/Acaricide*	2	✓	✓	✗	II
TEBUFENPYRAD	*Pyrazole*	1	✗	✗	✓	III
THIACLOPRID	*Neoniconitoid Insecticide/Molluscide*	33	✓	✓	✓	II
THIAMETHOXAM	*Neoniconitoid Insecticide*	38	✓	✓	✓	Not listed
TRIAZOPHOS	*Organophosphate Insecticide/Acaricide /Nematicide*	5	✓	✗	✗	Ib

Sources: **1** IUPAC Agrochemicals Footprint Database. http://sitem.herts.ac.uk/aeru/iupac/index.htm **2** CIBRC (2014) Insecticides/ Pesticides Registered under section 9 (3) of the Insecticides Act, 1968 for use in the country (as on 20/05/2014) Publ. CIBRC, India 7pp. Retrieved 05 June 2105. http://www.cibrc.nic.in/reg_products.doc **3** Tea Board of India (2014) Plant Protection Code Ref. No.: 12(18) LC/2010/5315. 21st March 2014. Retrieved 05 June 2014. http://www.teaboard.gov.in/pdf/notice/Circular1_PPC.pdf **4** IPCS (2009) The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification 2009. Publ WHO Geneva 78pp. http://www.who.int/ipcs/publications/pesticides_hazard_2009.pdf?ua=1

TABLE 4

LIST OF PESTICIDES FOUND IN TEA SAMPLES THAT ARE NOT APPROVED BY CIBRC OR THE TEA BOARD FOR USE IN TEA CULTIVATION SHOWN TOGETHER WITH THE BRANDS OF TEA IN WHICH THEY WERE FOUND

PESTICIDES	FOUND IN	PRODUCER & BRAND
ACEPHATE	Tata Tea Premium x2 Kanan Devan Brooke Bond Red Label x 2 Goodricke Chai Strong CTC Long Leaf Royal Girnar Cup Tea Tata Tea Gold Wagh Bakri Perfect Premium Leaf Tea Wagh Bakri Strong & Refreshing Premium Leaf Tea Brooke Bond Taj Mahal	Tata Global Beverages Ltd.: Tata Tea Premium Tata Global Beverages Ltd.: Kanan Devan Hindustan Unilever Ltd.: Brooke Bond Red Label Goodricke Group Ltd: Goodricke Chai Girnar Food & Beverages Pvt Ltd.: Girnar Tata Global Beverages Ltd.: Tata Tea Wagh Bakri: Wagh Bakri Wagh Bakri: Good Morning Premium Tea Wagh Bakri: Premium Leaf Tea Hindustan Unilever Ltd.: Brooke Bond Taj Mahal
ACETAMIPRID	Tata Tea Premium x 2 Red Label Natural Care Twinings English Breakfast x 2 Lipton Yellow Label Tea x 4 Wagh Bakri Strong and Refreshing Premium Leaf Tea x 2 Wagh Bakri Good Morning Tea Tetley With Elaichi Brooke Bond Red Label x 2 Kho Cha Masala Chai x 2 Kanan Devan Tata Tea Gold x 4 Lipton Darjeeling Tea Goodricke Chai Strong CTC Long Leaf Twinings Classsic Assam Tea Royal Girnar Cup Tea Wagh Bakri Perfect Premium Leaf Tea Tata Tea Life Brooke Bond 3 Roses Natural Care Brooke Bond Taj Mahal Brooke Bond Red Label Special	Tata Global Beverages Ltd.: Tata Tea Hindustan Unilever Ltd.: Brooke Bond Red Label Twinings Pvt Ltd.: English Breakfast Tea Hindustan Unilever Ltd.: Lipton Wagh Bakri: Good Morning Premium Tea Wagh Bakri: Good Morning Premium Tea Tata Global Beverages Ltd.: Tetley Hindustan Unilever Ltd.: Brooke Bond Red Label Kho Cha: Kho Cha Herb/Spice Tata Global Beverages Ltd.: Tata Tea Tata Global Beverages Ltd.: Tata Tea Hindustan Unilever Ltd.: Lipton Goodricke Group Ltd: Goodricke Chai Twinings Pvt Ltd.: Twinings Classic Assam Tea Girnar Food & Beverages Pvt Ltd.: Girnar Wagh Bakri: Wagh Bakri Tata Global Beverages: Tata Tea Hindustan Unilever: Brooke Bond Three Roses Hindustan Unilever: Brooke Bond Taj Mahal Hindustan Unilever: Brooke Bond Red Label
ANTHRAQUINONE	Golden Tips Pure Darjeeling Tea Lipton Clear Green Tea Brooke Bond Red Label Goodricke Thurbo Flavoury Darjeeling Tea	Golden Tips: Darjeeling Tea Hindustan Unilever: Lipton Hindustan Unilever Ltd.: Brooke Bond Red Label Goodricke Group Ltd: Goodricke Thurbo
CARBENDAZIM	Wagh Bakri Good Morning Tea Golden Tips Assam Tea Tata Tea Premium Brooke Bond 3 Roses Natural Care Goodricke Chai Strong CTC Long Leaf Brooke Bond Red Label	Wagh Bakri: Good Morning Premium Tea Golden Tips: Golden Tips Assam Tea Tata Global Beverages: Tata Tea Hindustan Unilever: Brooke Bond Three Roses Goodricke Group Ltd: Goodricke Chai Hindustan Unilever: Brooke Bond Red Label
CHLORPYRIFOS (-ETHYL)	Kho Chai Masala Chai Wagh Bakri Good Morning Tea	Kho Cha: Kho Cha Herb/Spice Wagh Bakri: Good Morning Premium Tea
CHLORPYRIFOS METHYL	Tata Tea Gold	Tata Global Beverages: Tata Tea
CLOTHIANIDIN	Tata Tea Premium x 2 Red Label Natural Care Twinings English Breakfast x 2 Lipton Yellow Label Tea x 3 Wagh Bakri Strong and Refreshing Premium Leaf Tea Wagh Bakri Good Morning Tea Tetley With Elaichi Twinings Earl Grey Twinings Classic Lady Grey Tata Tea Gold x 2 Kanan Devan Goodricke Chai Strong CTC Long Leaf Brooke Bond Red Label Twinings Classic Assam Tea	Tata Global Beverages: Tata Tea Hindustan Unilever: Brooke Bond Red Label Twinings Pvt Ltd.: Twinings English Breakfast Hindustan Unilever: Lipton Wagh Bakri: Good Morning Premium Tea Wagh Bakri: Good Morning Premium Tea Tata Global Beverages: Tetley Twinings Pvt Ltd.: Twinings Earl Grey Twinings Pvt Ltd.: Twinings Classic Lady Grey Tata Global Beverages: Tata Tea Tata Global Beverages: Tata Tea Goodricke Group Ltd: Goodricke Chai Hindustan Unilever: Brooke Bond Red Label Twinings Pvt Ltd.: Twinings Classic Assam Tea
CYFLUTHRIN	Tetley With Elaichi Wagh Bakri Strong & Refreshing Premium Leaf Tea	Tata Global Beverages: Tetley Wagh Bakri: Good Morning Premium Tea

PESTICIDES	FOUND IN	PRODUCER & BRAND
CYFLUTHRIN	Tata Tea Premium	Tata Global Beverages: Tata Tea
	Red Label Natural Care	Hindustan Unilever: Brooke Bond Red Label
	Wagh Bakri Strong and Refreshing Premium Leaf Tea x 2	Wagh Bakri: Good Morning Premium Tea
	Wagh Bakri Good Morning Tea	Wagh Bakri: Good Morning Premium Tea
	Tetley Long Leaf Green Tea	Tata Global Beverages: Tetley
	Lipton Yellow Label Tea x 2	Hindustan Unilever: Lipton
	Twinings English Breakfast	Twinings Pvt Ltd. Twinings English Breakfast
	Tetley With Elaichi	Tata Global Beverages: Tetley
CARBENDAZIM	Goodricke Thurbo Flavoury-Darjeeling Tea	Goodricke Group Ltd: Goodricke Thurbo
	Twinings Classsic Assam Tea	Twinings Pvt Ltd. : Twinings Classic Assam Tea
	Wagh Bakri Perfect Premium Leaf Tea	Wagh Bakri: Good Morning Premium Tea
	Kho Cha Masala Chai	Kho Cha: Kho Cha Herb/Spice
	Brooke Bond 3 Roses Natural Care	Hindustan Unilever: Brooke Bond Three Roses
	Brooke Bond Red Label Special	Hindustan Unilever: Brooke Bond Red Label
	Tata Tea Gold	Tata Global Beverages: Tata Tea
	Goodricke Chai Strong CTC Long Leaf	Goodricke Group Ltd: Goodricke Chai
	Brooke Bond Red Label	Hindustan Unilever: Brooke Bond Red Label
CYPERMETHRIN	Brooke Bond	Hindustan Unilever: Brooke Bond
	Tata Tea Premium x 3	Tata Global Beverages: Tata Tea
	Red Label Natural Care	Hindustan Unilever: Brooke Bond Red Label
	Twinings English Breakfast x 2	Twinings Pvt Ltd. : Twinings English Breakfast
	Lipton Yellow Label Tea x 4	Hindustan Unilever: Lipton
	Lipton Darjeeling Tea	Hindustan Unilever: Lipton
	Wagh Bakri Strong & Refreshing Premium Leaf Tea x 2	Wagh Bakri: Good Morning Premium Tea
	Wagh Bakri Good Morning Tea	Wagh Bakri: Good Morning Premium Tea
	Tetley Long Leaf Green Tea	Tata Global Beverages: Tetley
	Brooke Bond Red Label x 2	Hindustan Unilever: Brooke Bond Red Label
	Tetley With Elaichi	Tata Global Beverages: Tetley
	Twinings Classic Lady Grey	Twinings Pvt Ltd.: Twinings Classic Lady Grey
	Kho Cha Masala Chai x 2	Kho Cha: Kho Cha Herb/Spice
	Tata Tea Gold x 4	Tata Global Beverages: Tata Tea
	Kanan Devan	Tata Global Beverages: Tata Tea
	Goodricke Chai Strong CTC Long Leaf	Goodricke Group Ltd: Goodricke Chai
	Twinings Classic Assam Tea	Twinings Pvt. Ltd.: Twinings Classic Assam Tea
	Royal Girnar Cup Tea	Girnar Food & Beverages Pvt. Ltd: Girnar
	Wagh Bakri Perfect Premium Leaf Tea	Wagh Bakri: Good Morning Premium Tea
	Golden Tips Assam Tea	Golden Tips: Assam Tea
	Tata Tea Life	Tata Global Beverages: Tata Tea
	Brooke Bond 3 Roses Natural Care	Hindustan Unilever: Brooke Bond Three Roses
	Brooke Bond Taj Mahal	Hindustan Unilever: Brooke Bond Taj Mahal
	Brooke Bond Red Label Special	Hindustan Unilever: Brooke Bond Red Label

PESTICIDES	FOUND IN	PRODUCER & BRAND
DDT	Tata Tea Premium x 3	Tata Global Beverages: Tetley
	Red Label Natural Care	Hindustan Unilever: Brooke Bond Red Label
	Twinings English Breakfast X 2	Twinings Pvt Ltd. Twinings English Breakfast
	Lipton Yellow Label Tea X 4	Hindustan Unilever: Lipton
	Wagh Bakri Strong and Refreshing Premium Leaf Tea x 2	Wagh Bakri: Good Morning Premium Tea
	Wagh Bakri Good Morning Tea	Wagh Bakri: Good Morning Premium Tea
	Brooke Bond Red Label x 2	Hindustan Unilever: Brooke Bond Red Label
	Tetley with Elaichi	Tata Global Beverages: Tetley
	Kho Cha Masala Chai x 2	Kho Cha: Kho Cha Herb/Spice
	Tata Tea Gold x 4	Tata Global Beverages: Tata Tea
	Kanan Devan	Tata Global Beverages: Tata Tea
	Goodricke Chai Strong CTC Long Leaf	Goodricke Group Ltd: Goodricke Chai
	Twinings Classic Assam Tea	Twinings Pvt Ltd: Twinings Classic Assam Tea
	Royal Girnar Cup Tea	Girnar Food & Beverages Pvt. Ltd: Girnar
	Wagh Bakri Perfect Premium Leaf Tea	Wagh Bakri: Good Morning Premium Tea
	Golden Tips Assam Tea	Golden Tips: Assam Tea
	Tata Tea Life	Tata Global Beverages: Tata Tea
	Brooke Bond 3 Roses Natural Care	Hindustan Unilever: Brooke Bond Three Roses
	Brooke Bond Taj Mahal	Hindustan Unilever: Brooke Bond Three Roses
	Brooke Bond Red Label Special	Hindustan Unilever: Brooke Bond Red Label
	Brooke Bond	Hindustan Unilever: Brooke Bond
ENDOSULFAN	Golden Tips Pure Darjeeling Tea	Golden Tips: Golden Tips Darjeeling Tea
	Twinings Earl Grey	Twinings Pvt Ltd.: Twinings Earl Grey
	Twinings Classic Lady Grey	Twinings Pvt Ltd.: Twinings Classic Lady Grey
	Kho Cha Masala Chai	Kho Cha: Kho Cha Herb/Spice
FENVALERATE	Tetley Long Leaf Green Tea	Tata Global Beverages: Tetley
	Brooke Bond	Hindustan Unilever: Brooke Bond Red Label
	Lipton Yellow Label Tea x 2	Hindustan Unilever: Lipton
	Brooke Bond Red Label x 2	Hindustan Unilever: Brooke Bond Red Label
	Goodricke Chai Strong CTC Long Leaf	Goodricke Group Ltd: Goodricke Chai
	Brooke Bond Taj Mahal	Hindustan Unilever: Brooke Bond Three Roses
	Brooke Bond Red Label Special	Hindustan Unilever: Brooke Bond Red

PESTICIDES	FOUND IN	PRODUCER & BRAND
FIPRONIL	Goodricke Chai Strong CTC Long Leaf	Goodricke Group Ltd: Goodricke Chai
IMIDACLOPRID	Brooke Bond	Hindustan Unilever: Brooke Bond
	Tata Tea Premium x 3	Tata Global Beverages: Tata Tea
	Red Label Natural Care	Hindustan Unilever: Brooke Bond Red Label
	Lipton Yellow Label Tea x 4	Hindustan Unilever: Lipton
	Wagh Bakri Strong And Refreshing Premium Leaf Tea x 2	Wagh Bakri: Good Morning Premium Tea
	Tetley Long Leaf Green Tea	Tata Global Beverages: Tetley
	Tetley With Elaichi	Tata Global Beverages: Tetley
	Brooke Bond Red Label x 2	Hindustan Unilever: Brooke Bond Red Label
	Tata Tea Gold x 4	Tata Global Beverages: Tata Tea
	Kanan Devan	Tata Global Beverages: Tata Tea
	Goodricke Chai Strong CTC Long Leaf	Goodricke Group Ltd: Goodricke Chai
	Royal Girnar Cup Tea	Girnar Food & Beverages Pvt. Ltd: Girnar
	Wagh Bakri Perfect Premium Leaf Tea	Wagh Bakri: Good Morning Premium Tea
	Kho Cha Masala Chai	Kho Cha: Kho Cha Herb/Spice
	Tata Tea Life	Tata Global Beverages: Tata Tea
	Brooke Bond 3 Roses Natural Care	Hindustan Unilever: Brooke Bond Three Roses
	Brooke Bond Taj Mahal	Hindustan Unilever: Brooke Bond Three Roses
	Brooke Bond Red Label Special	Hindustan Unilever: Brooke Bond Red Label
	Twinings Darjeeling Tea	Twinings Pvt Ltd.: Twinings Darjeeling Tea
	Wagh Bakri Good Morning Tea	Wagh Bakri: Good Morning Tea
METHAMIDOPHOS	Goodricke Chai Strong CTC Long Leaf	Goodricke Group Ltd: Goodricke Chai
	Brooke Bond Red Label	Hindustan Unilever: Brooke Bond Red Label
MONOCROTOPHOS	Brooke Bond	Hindustan Unilever: Brooke Bond
	Tata Tea Premium x 3	Tata Global Beverages: Tata Tea
	Red Label Natural Care	Hindustan Unilever: Brooke Bond Red Label
	Lipton Yellow Label Tea x 3	Hindustan Unilever: Lipton
	Wagh Bakri Strong And Refreshing Premium Leaf Tea x 2	Wagh Bakri: Good Morning Premium Tea
	Brooke Bond Red Label x 2	Hindustan Unilever: Brooke Bond Red Label
	Kho Cha Masala Chai x 2	Kho Cha: Kho Cha Herb/Spice
	Tata Tea Gold x 4	Tata Global Beverages: Tata Tea
	Kanan Devan	Tata Global Beverages: Tata Tea
	Goodricke Chai Strong CTC Long Leaf	Goodricke Group Ltd: Goodricke Chai
	Royal Girnar Cup Tea	Girnar Food & Beverages Pvt. Ltd: Girnar
	Wagh Bakri Perfect Premium Leaf Tea	Wagh Bakri: Good Morning Premium Tea
	Golden Tips Assam Tea	Golden Tips: Assam Tea
	Tata Tea Life	Tata Global Beverages: Tata Tea
	Brooke Bond 3 Roses Natural Care	Hindustan Unilever: Brooke Bond Three Roses
	Brooke Bond Taj Mahal	Hindustan Unilever: Brooke Bond Taj Mahal
	Brooke Bond Red Label Special	Hindustan Unilever: Brooke Bond Red Label

PESTICIDES	FOUND IN	PRODUCER & BRAND
MYCLOBUTANIL	Kho Cha Masala Chai	Kho Cha: Kho Cha Herb/Spice
PERMETHRIN	Red Label Natural Care	Hindustan Unilever: Brooke Bond Red Label
	Tetley Long Leaf Green Tea	Tata Global Beverages: Tetley
	Goodricke Chai Strong CTC Long Leaf	Goodricke Group Ltd: Goodricke Chai
	Brooke Bond Red Label	Hindustan Unilever: Brooke Bond Red Label
TEBUFENPYRAD	Red Label Natural Care	Hindustan Unilever: Brooke Bond Red Label
TRIAZOPHOS	Tata Tea Gold	Tata Global Beverages: Tata Tea
	Brooke Bond Red Label x 2	Hindustan Unilever: Brooke Bond Red Label
	Tata Tea Premium	Tata Global Beverages: Tata Tea
	Wagh Bakri Strong & Refreshing Premium Leaf Tea	Wagh Bakri: Good Morning Premium Tea

TABLE 5

DATA FROM THE IUPAC FOOTPRINT PESTICIDE DATABASE FOR STATED HUMAN HEALTH IMPACTS OF PESTICIDES DETECTED IN THIS STUDY.

PESTICIDES FOUND	CARCINOGEN	MUTAGEN	EDC	REPRODUCTIVE AND DEVELOPMENT EFFECTS	ACH INHIBITOR	NEURO-TOXICANT	IRRITANT			*NOTES*
							RESP	SKIN	EYES	
ACEPHATE	?	N	Y	N/D	Y	Y	N/D	?	N/D	
ACETAMIPRID	N	N/D	N/D	N/D	N	N	N	Y	Y	
ANTHRAQUINONE	?	N/D	N	N	N	?	N	Y	N	Skin sensitiser, may cause dermatitis
BIFENTHRIN	?	?	Y	?	N	Y	N/D	N	N	Skin sensitiser. may cause tremors/staggered gait
CARBENDAZIM	?	N/D	?	Y	N	N	N	N	N	Possible liver enzyme induction/liver toxicant
CHLORPYRIFOS (-ETHYL)	N	N	?	Y	Y	Y	N	Y	Y	Highly toxic, possible link with learning difficulties, possible blood toxicant
CHLORPYRIFOS (-METHYL)	N	N/D	N	N/D	Y	Y	N	Y	N	Highly Toxic, possible link with learning difficulties in children
CLOTHIANIDIN	N	N	?	N	N	Y	N	N	N	Possible EDC effects noted in rodents and dogs. May cause hypotenstion/hypothermia and impaired pupillar function
CYFLUTHRIN	N	N	N/D	?	N	Y	N	Y	N/D	Highly toxic, possible liver/kidney toxicant
CYHALOTHRIN LAMBDA	N/D	N/D	Y	N/D	N	N/D	?	Y	Y	Moderately toxic
CYPERMETHRIN	?	N	?	?	N	N	Y	Y	Y	Highly toxic
DDT	?	Y	Y	N	Y	?	N	N	N/D	Highly toxic
DELTAMETHRIN	?	N	Y	?	N	Y	N	N	N	No information available
DICOFOL	?	N	?	N/D	N	Y	Y	Y	Y	Harmful by inhalation, ingestion, skin contact
ENDOSULFAN	?	Y	?	N/D	N	Y	N/D	N/D	N/D	Mutagenic potential,, highly toxic
ETHION	N	N	N/D	?	Y	Y	N/D	N/D	N/D	Bioaccumulates
FENAZAQUIN	N	N/D	N	?	N	N/D	Y	N	N	Possible liver toxicant, harmful by inhalation
FENPROPATHRIN	N	N/D	N/D	N/D	N	N	Y	N/D	N/D	Highly toxic
FENPYROXIMATE	N	N/D	N/D	Y	N	N	N/D	Y	Y	Possible sensitiser
FIPRONIL	?	N/D	?	N/D	N	Y	N/D	Y	Y	Thyroid, liver, kidney toxicant. Bioaccumulates Highly toxic

PESTICIDES FOUND	CARCINOGEN	MUTAGEN	EDC	REPRODUCTIVE AND DEVELOPMENT EFFECTS	ACH INHIBITOR	NEURO-TOXICANT	IRRITANT			*NOTES*
							RESP	SKIN	EYES	
Fenvalerate	N	N/D	Y	N/D	N	N	Y	Y	Y	Ingestion may cause abdominal pain/convulsions
Hexaconazole	?	N/D	N/D	N/D	N	N	N/D	Y	Y	Skin sensitiser
Imidacloprid	N	?	N/D	Y	N	?	N	?	?	Potential liver, kidney, thyroid, heart, spleen toxicant
Methamidophos	N	Y	N/D	?	Y	Y	N	N	N	Highly toxic
Monocrotophos	N	Y	N/D	?	Y	Y	N	Y	Y	Highly toxic orally
Myclobutanil	N	N/D	N/D	?	N	N	N	N	N	Liver toxicant
Permethrin	?	N	Y	Y	?	Y	N/D	Y	Y	
Profenofos	N	N/D	N/D	N	Y	Y	N/D	Y	?	Harmful by inhalation
Propargite	?	N/D	N/D	Y	N	N	N	Y	Y	Skin sensitiser/may cause dermatitis. Toxic by inhalation
Quinalphos	N	N/D	N/D	?	Y	Y	Y	Y	Y	Highly toxic, may be fatal if inhaled, swallowed or absorbed through the skin.
Tebufenpyrad	?	N/D	N/D	N	N/D	N/D	Y	N	N	Skin sensitiser, possible liver toxicant
Thiacloprid	?	N/D	N/D	N/D	N	N/D	N	N	N	Possible liver and thyroid toxicant
Thiamethoxam	?	N/D	N	N	N	N	N	?	N	Increased incidence liver carcinoma and adenocarcinoma in mice
Triazophos	N	N/D	N/D	N/D	Y	Y	Y	Y	Y	Toxicant to most major organs

Source: University of Hertfordshire (2013). The Pesticide Properties DataBase (PPDB) developed by the Agriculture & Environment Research Unit (AERU), University of Hertfordshire, 2006-2013.

Key: Y= Yes, known to cause a problem; N= No, known not to cause a problem; ? = Possibly, status not identified. N/D= No data. This list is not exhaustive and is for guidance purposes only.

Ach= acetyl-cholinesterase inhibitor; Resp. = respiratory system; EDC= endocrine disrupting

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