University of Delhi

RC/2015/9435 31 August, 2015

The Principal,
Shivaji College
Ring Road, Raja Garden,
New Delhi-27

Subject: - **Innovation Projects 2015-16**

Dear Principal,

The University of Delhi is pleased to announce the third round of the undergraduate research initiative in colleges, Innovation Projects 2015-16. You will be glad to know that the following project submitted by your college has been selected for award

Project Code: SHC 313
Project Title: Comparative Analysis Of Heavy Metal Toxicity And Pesticide Contamination In Vegetables Collected From Local Sites And Organic Stores In Delhi

The distribution of grant under different budget heads as below:

Sr. No.	Budget Head	Amount
1.	Equipment/Consumables	Rs 3,25,000/-
2.	Stipends	Rs. 1,20,000/- (1000x10x12)
3.	Travel	Rs 55,000/-
4.	Honorarium	Rs 25,000/-
5.	Stationery/Printing	Rs 20,000/
6.	Contingency	Rs 55,000/-
	Total	Rs 600,000/-
Rs 6 lakhs (Rupees six lakhs only)		
Amount to be released in first phase by Finance Branch- Rs 450,000/		

Budget head No. 1 and half of the remaining grant will be released as the first instalment. The second and final instalment will be released after submission of half-yearly report (by 15 February 2016), satisfactory review and recommendation of release of the second instalment.
Please refer to the detailed guidelines for implementation of the project. Any queries may be addressed to- innovationprojects1516@gmail.com.

With best wishes,

Yours sincerely,

Prof. Malashri Lal

Comparative analysis of heavy metal toxicity and pesticide contamination in vegetables collected from local sites and organic stores in Delhi

Final Project Report

Delhi University Innovation Project SHC-313, 2015-16

Shivaji College
University of Delhi
Raja Garden
New Delhi -110027

Submitted by

Dr. Shashi Nijhawan
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Mentor

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EMTRC Consultants Pvt. Ltd.,
NABET, Accredited EIA Firm & MOEF Recognized Lab, Delhi - 32

UNVERSITY OF DELHI

INNOVATION PROJECTS 2015-16

FINAL REPORT

1. PROJECT CODE: **SHC 313**

2. PROJECT TITLE: **Comparative analysis of heavy metal toxicity and pesticide contamination in vegetables collected from local sites and organic stores in Delhi**

3. NAME OF COLLEGE/INSTITUTION: **Shivaji College, University of Delhi**

4. PRINCIPAL INVESTIGATORS

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5. MENTOR
   Dr. J. K. Moitra
   EMTRC Consultants Pvt. Ltd.,
   NABET Accredited EIA Firm & MOEF Recognized Lab, Delhi - 32

6. STUDENTS INVOLVED IN THE PROJECT

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University of Delhi

Certificate of Originality

This is to certify that the research work carried out and the final report submitted by the Project Investigators and the students of Innovation Project having Project code **SHC 313** and title "**Comparative analysis of heavy metal toxicity and pesticide contamination in vegetables collected from local sites and organic stores in Delhi**" of Shivaji College is original. Any plagiarism/academic dishonesty reported at any stage will be our responsibility.

(Dr Shashi Nijhawan)
Department of Biochemistry

(Dr Aeshna Nigam)
Department of Zoology

(Dr Kiran Bamel)
Department of Botany

Final Report

1. **Project Title**

Comparative analysis of heavy metal toxicity and pesticide contamination in vegetables collected from local sites and organic stores in Delhi.

2. **Project Code**

SHC 313

3. **Abstract**

Vegetables form an essential part of our diet and provide us with nutrients, fibre and antioxidants. Past fifty years of industrialization, urbanization and 'Green Revolution' has polluted our environment. Some of these pollutants include pesticides and heavy metals like Lead (Pb) and Cadmium (Cd). Growing vegetables in this environment contaminate the food we eat causing severe health implications. To investigate the vegetables, three sites were chosen in Delhi-NCR region where vegetables are grown locally- Yamuna floodplains (Nizamuddin), Hindon floodplain, Nilothi village (near Najafgarh nallah). Vegetables grown in Lady Irwin College, University of Delhi were collected for organic produce. Pb contamination was found in vegetables collected from Najafgarh and in some of the organic vegetables. The Bio Concentration Factor (BCF) for all vegetables were above 1 making them unfit for raw consumption. High levels of Persistent Organic Pollutants (POPs) were found in all the vegetables including organic produce. A second round of sampling was carried out in summer from Najafgarh and Azadpur Mandi to check the heavy metal and pesticide levels in them. In comparison to winter vegetables, summer vegetables had heavy metals below permissible levels. The BCF factor for most vegetables was also below 1. However, pesticide levels were above permissible levels. It was concluded that it is better to consume vegetables from Azadpur Mandi instead of the local produce. Organic farming does not prevent heavy metal contamination if the environment is contaminated. A **'Lab to Land'** initiative was taken to create awareness among the farmers of the current situation.

4. **Introduction**

Vegetables form an essential part of human diet. They are the main source of nutrients, fibre and antioxidants, which are important for our health. It has been a tradition, all over the world to grow these vegetables on the fringe of urban areas. However, recent trends in industrialization and unplanned urbanization and 'Green Revolution' in the field of agriculture have resulted in deterioration of environment of these periurban regions and the crops grown in them. Air, water and soil, which form the growth media for the vegetables, are heavily polluted with industrial effluents, wastewater, untreated sewage water, vehicular emission and indiscriminate use of pesticides. These pollutants include metals like Cu, Pb, Cd Cr, Hg, and As, some of which are highly toxic even at low concentration.These toxic elements enter the food chain by consumption of vegetables, which are often grown in contaminated environment. Depending on the nature of vegetables, different vegetables accumulate variable concentration of metals in

different parts of the vegetable crop. Green vegetables are seen to accumulate highest concentration of these heavy metals and pesticides.

India is now the second largest manufacturer of pesticides in Asia after China and ranks twelfth globally.The pattern of pesticide usage in India is different from that for the world in general. In India 76% of the pesticide used is insecticide, as against 44% globally. Technology and development have increased the comfort level for society of man without paying heed to the detriorating effects on environment and our food .

5. Research problem

With the ever increasing concern of food adulteration and their contamination from various sources, health risk assessment has come up as a prime concern in food and agricultural sector in Delhi. Various sources of soil and water pollution have added toxic contaminants to plant based food items grown in and around the industrial areas of the city. Ground water contamination and pollution of Yamuna water caused by industrial effluents and improper management of sewage disposal is of prime concern. However, contamination of crops due to agricultural source caused by the rigorous application of pesticides and insecticides also pose serious health risks in humans and animals ranging from mild to chronic diseases and even malignant symptoms. Inorganic heavy metal contaminations due to pollution and accumulation of organo-phospho and organo-chlorinated pesticides are the major contaminants expected to be found in plant based food items. Application of carbide (Fruit ripening enhancer) and oxytocin (growth inducer) in fruits and vegetables pose serious health risk in children and adults.

Recent reports suggest the levels of heavy metal accumulation (Cr, Ni, Pb and Cu) to have exceeded the permissible limit and thus affecting the ground water in regions of Shahdara block and Najafgarh area of Delhi. The National Green Tribunal (NGT) recommends the halt of vegetable cultivation in the Yamuna bank of Khadar area. Central pollution control board (CPCB) reports the effect of heavy sewage disposal by Najafgargh drain responsible for the rise in BOD (biological oxygen demand) load in water of Yamuna river. UP pollution control board reported the deadly polluted status of Hindon river accumulating industrial effluents from 172 industries present in the cities of Ghaziabad, Gautam buddh nagar and Meerut. Since most of these industries involve dye-manufacturing, electroplating and pesticide factories in addition to animal slaughter houses, water in hindon river has been expected to accumutlate high levels of toxic heavy metals and pesticides. Consumption of vegetables grown in polluted water is reported to cause prevalence of vomiting, diarrhea, gastroenteritis, blood infection, dehydration, urinary infection and kidney dysfunction.

Organic farming is one of the preferred eco-friendly alternatives to the usage of artificial pesticides and fertilizers. The use of green manure, compost and biological control of pests nullifies the possibility of toxic pesticides and insecticides to accumulate within the vegetables and enter the food chain by biological maginification.

In view of the above concerns and remedies the objective of the project was to provide a comparative analysis of heavy metal toxicity and pesticide contamination in vegetables collected from four local sites with that obtained from organic stores in Delhi. Furthermore the quality of cultivation soil will also be investigated to detect such possible contaminants.

Aim of the project

- Field visits to local farms and organic vegetable farms to compare differences in the pattern of farming
- Analysis of heavy metal toxicity
- To examine the presence of organo-phospho and organo-chloro pesticides
- To compare the levels of toxic accumulation in vegetables collected from local sites with that obtained from organic farm.
- Put forward recommendations on the basis of data collected

6. Methodology

- Choice of Experimental site
- Sampling methods
- Sample preparation and processing
- Processing of soil

Choice of Experimental site

Two rounds of sampling was done: During the first round in winter season, 2015 three sites were identified where vegetables are grown in Delhi/NCR region and supplied to local markets:

Site A: Najafgarh drain near village Nilothi , Najafgarh
Site B: Hindon river bank near the city Ghaziabad
Site C: Cultivated Area near Nizammudin Bridge

Vegetables were also procured from Lady Irwin College (Site D), University of Delhi where organic farming is carried out. These samples will serve as organic samples.
During the second round as per suggestion of the panel, vegetables were also procured from the vegetable vendors in Azadpur mandi (Site E) and tested alongwith vegetables collected from Najafgarh at the vicinity of battery factory in the summer season, 2016.

Sampling methods

Soil/irrigation water samples and vegetables were collected from these 3 agricultural sites in Delhi and NCR regions which were identified in the range mild to severely polluted sites along with organic farm.Vegetable samples were also collected from Azadpur mandi. To the irrigation water collected, 1ml of conc. nitric acid was immediately added on site to 100 ml water sample to prevent oxidation of metals.

Sample preparation

Vegetables

- All the samples were washed in running tap water and then soaked for half an hour [in cold (series 1) and hot water (series 2)] and then air-dried.
- Two samples of the vegetables were prepared: a) Unpeeled and b)peeled (depending upon the type of vegetable).
- The samples were cut down into pieces and weighed.
- The weighed sample was placed into pre-heated oven (105 C) to remove moisture content.
- The dried sample was ground into powder form and weighed.

Soil

- The soil collected was air dried to ensure no moisture content was left in it.
- The pH of the soil was measured using universal indicator (Fisher Scientific)

For Heavy metal Analysis

Vegetable samples

- The powder of the vegetable samples acid digested
- 5ml of conc. nitric acid was added to 2g of sample and heated at 80 C till all nitric acid was evaporated
- The digested sample was diluted in 50 ml deionised water and filtered (Whatman no. 41)
- Filterate was sent for atomic absorption analysis (AAS) to Institute of Life Long Learning (ILLL)

Soil samples

- The soil samples were air dried and ground into fine powder
- 5ml of conc. nitric acid was added to 2g of sample and heated at 80 C till all nitric acid evaporated
- The digested sample was diluted in 50 ml deionised water and filtered (Whatman no. 41)
- Filterate was sent for AAS to ILLL.

For Pesticide Analysis

The dried vegetables and soil was sent to EMRTC laboratory for GC analyses.

7. Result and Discussion

Heavy Metals

In order to evaluate the potential threat of heavy metals to human health, the concentrations of heavy metals in the edible parts of the vegetables, the soil in which they are grown and the irrigation water used in Delhi-NCR region was investigated.

Soil

The pH of the soils from the four sites varied from 6.5-8 (mean= 7.4) with Najafgarh soil being slightly acidic since the area is irrigated with water mixed with wastewater from battery factory. The values are well within the levels recommended by CPCB, India for agricultural land. The pH of the soil influences the bioavailability of the heavy metals to the plant. As the alkalinity of the soil increases the availability of the heavy metals to the plant decreases.This may also prove to be harmful resulting in the subsequent accumulation of heavy metals in agricultural land over the years.

Copper (Cu) and Zinc (Zn) are the essential microelements, however when present in excess can inhibit the metabolic activities of plants. Excessive exposure to Cu causes cellular damage leading to Wilson'sdisease. The acute exposure of zinc can cause tachycardia, vascular shock, dyspeptic nausea, vomiting, pancreatic disorder, diarrhea and damage of hepatic parenchyma. The Cu and Zn content in all the soils were found to be well within the permissible level. Cd and Pb on the other hand are well known plant toxins. Despite the roots being selective of the mineral uptake these toxic elements are also taken up and accumulated in the plant. All the metals were found to be within the safe limits as set by WHO.

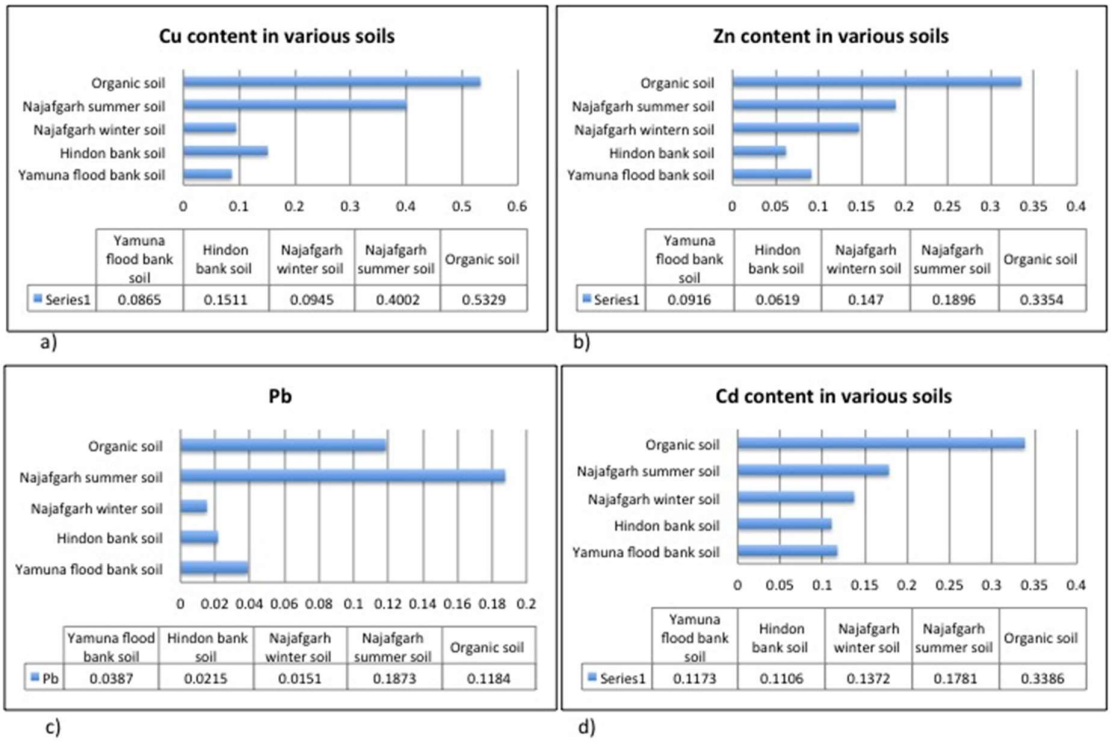
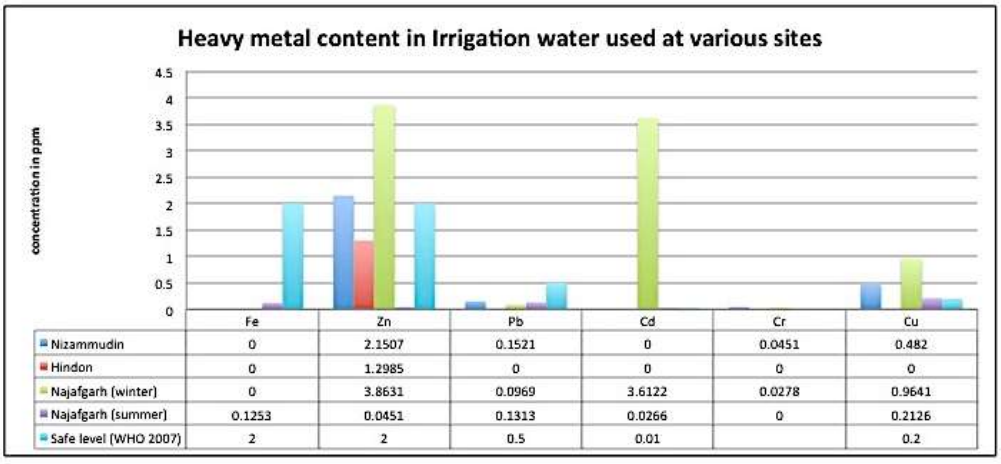


Figure 1: The heavy metals found in various soils in ppm. As per WHO maximum permissible levels of Cu, Zn, Pb and Cd in soil are 100, 300, 100 and 3ppm

Irrigation water

Very high levels of Cu, Cd and Zn were found in the irrigation water (winter) used from Najafgarh nallah and Yamuna river near Nizamuddin as seen in Fig 2. High levels of Cd was found in irrigation water collected from Najafgarh in summer. A major reason for this maybe the discharge of wastewater from the industries right adjacent to the agricultural land. If left untreated wastewater would have a high content of heavy metals. During sampling it was observed that the wastewater from the battery factory was discharged directly into the Najafgarh nallah, which is used for the irrigation of the adjacent agricultural land.



	Fe	Zn	Pb	Cd	Cr	Cu
Nizammudin	0	2.1507	0.1521	0	0.0451	0.482
Hindon	0	1.2985	0	0	0	0
Najafgarh (winter)	0	3.8631	0.0969	3.6122	0.0278	0.9641
Najafgarh (summer)	0.1253	0.0451	0.1313	0.0266	0	0.2126
Safe level (WHO 2007)	2	2	0.5	0.01		0.2

Figure 2: Graph showing the concentration of various heavy metals in irrigation water.

Vegetables

Heavy metals are mobile and easily taken up by plants grown in metal contaminated environment. Sinc ethe plant has the ability to accumulate metals in different parts from environment, eating such vegetables may pose health implications. In the study that was carried out investigations were carried out for Cu, Zn, Pb and Cd accumulation in the edible part of the plant, i.e. vegetable.

According to WHO, if fresh produce contain essential elements like Zn and Cuin amounts high concentrations, it would harm the human beings. The sites from where the vegetables were collected are irrigated with polluted water. River Yamuna which is considered as the lifeline of Delhi is one of the most polluted rivers. Najafgarh drain as reported by CPCB, 2007 is one of the major polluting drains of Delhi, carrying the wastewater from the industries as well as freshwater released by Haryana into irrigation canal. Hindon river too, is a highly polluted river as it receives both treated and untreated municipal and industrial discharges generated in and around Ghaziabad, India. The levels of Cu and Zn collected from all sites were found to be within permissible levels. The MPL by WHO is of 30 and 50 ppm of Cu and Zn respectively (Fig 3).

Toxic elements like Pb and Cd are harmful even at low concentrations.Both of them are very toxic and are carcinogens. Exposure to high Pb levels can severely damage the brain andkidneys,cause miscarriage in pregnant women, damage the sperm production organs and ultimately cause death.

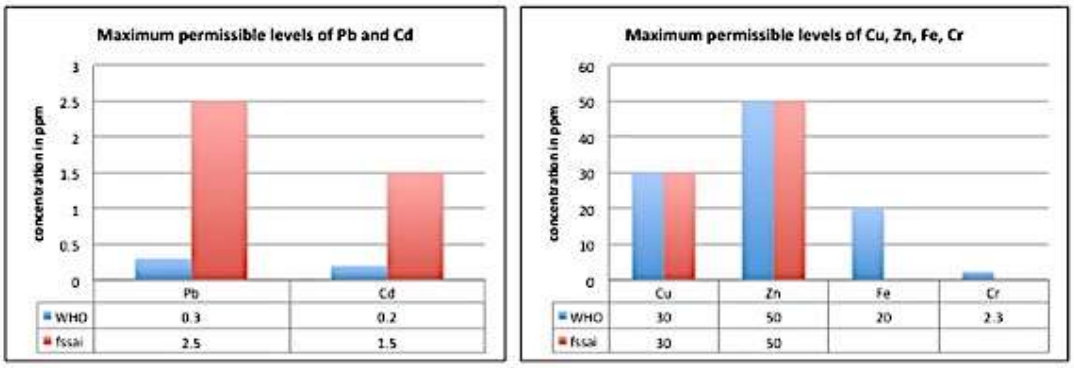


Figure 3: Maximum permissible levels for heavy metals as set by WHO and Food Safety and Standard Authority of India (*fssai)*.

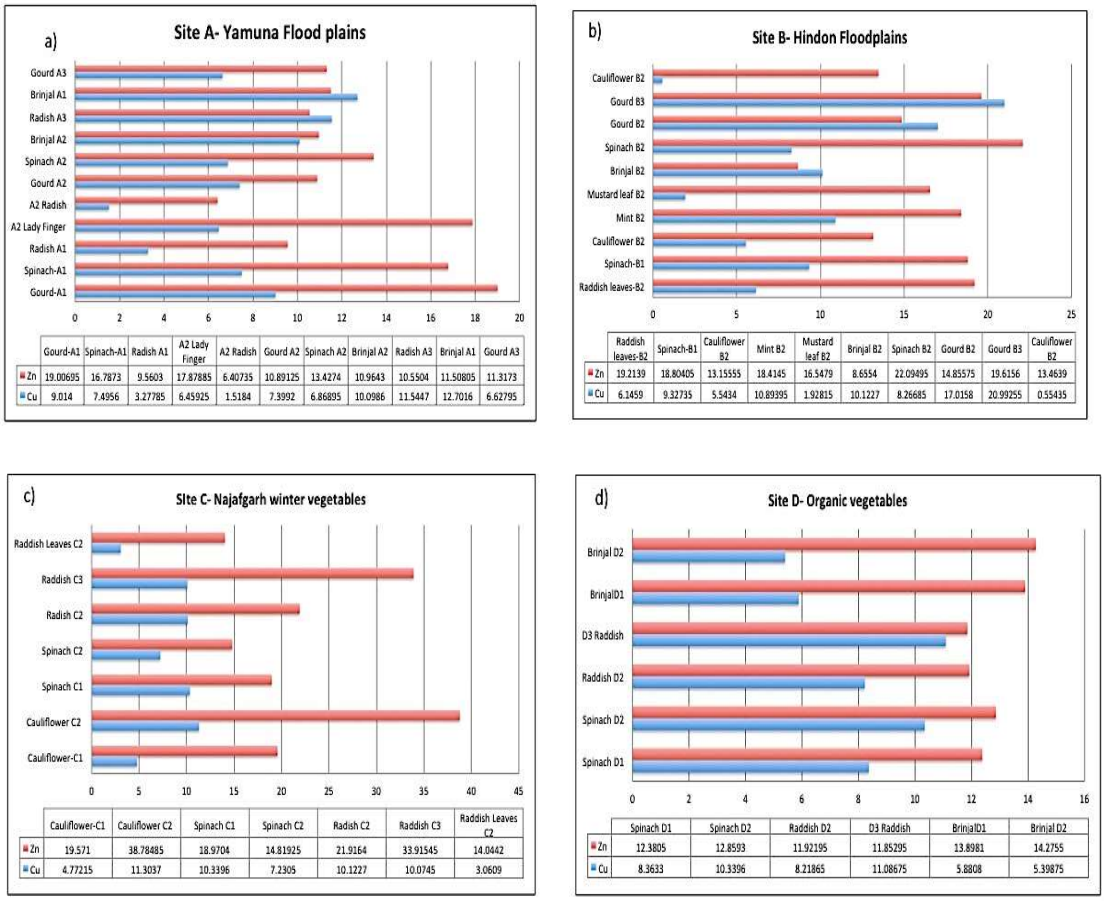


Figure 4: Various levels ofCu and Zn detected from winter vegetables (in ppm) collected from Yamuna flood plains (near Nizamuddin), Hindon flood plains, near Najafgarh nallah (winter) and organic farm at Lady Irwin College, University of Delhi.

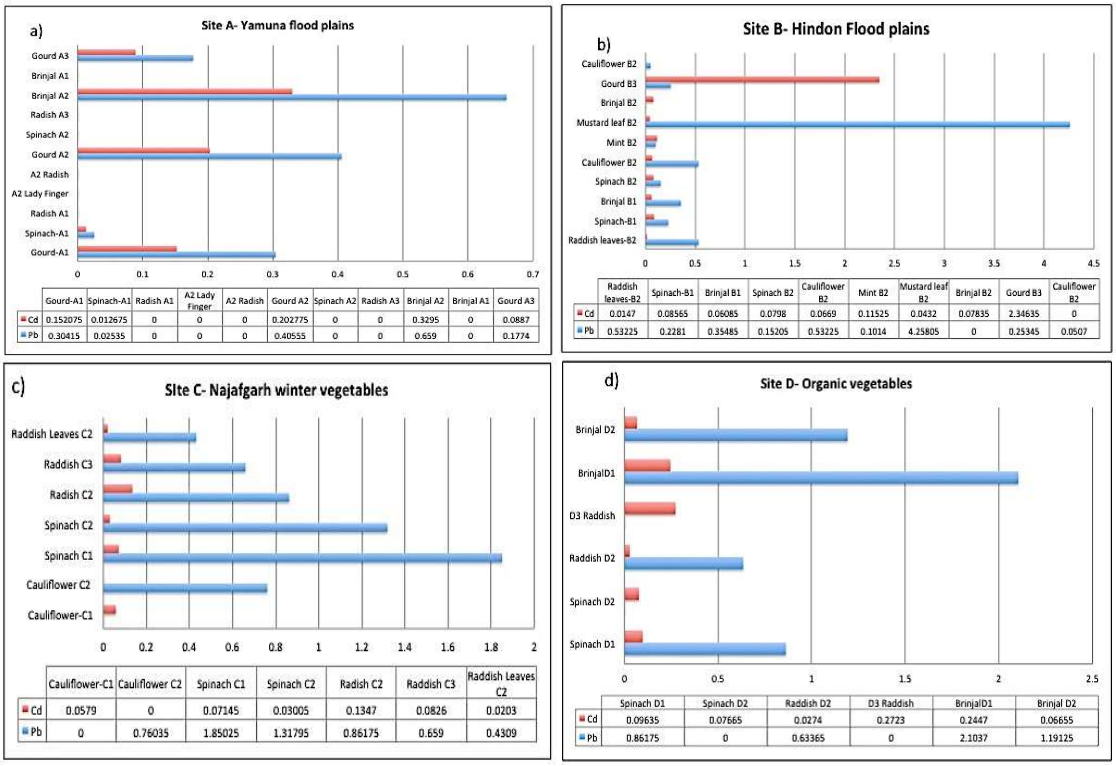
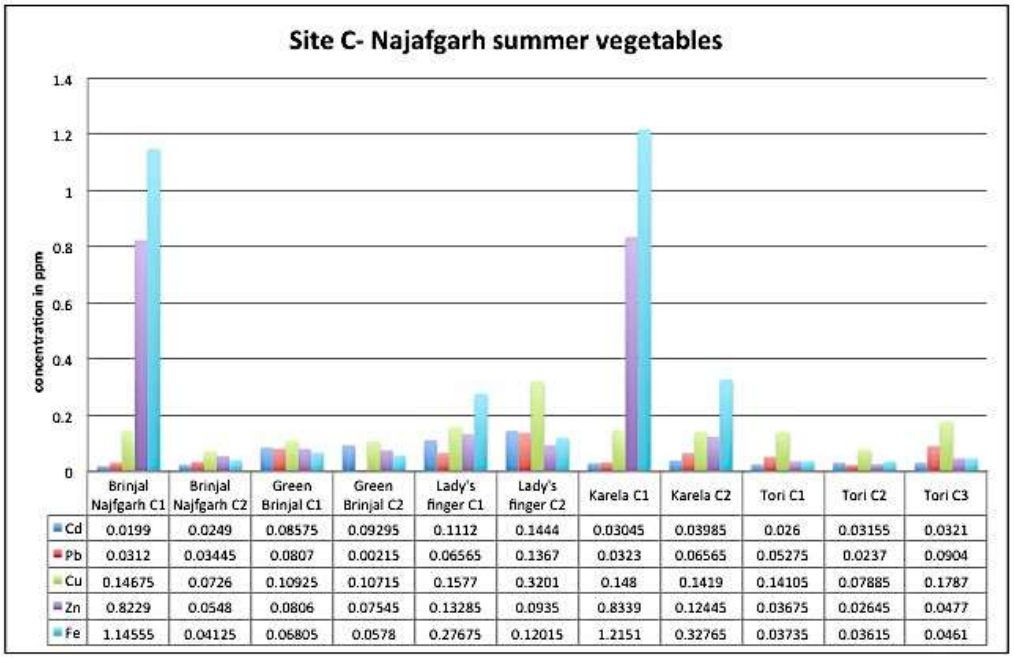


Figure 5: Various levels of Pb and Cd detected from winter vegetables (in ppm) collected from Yamuna flood plains(near Nizamuddin), Hindon floodplains, near Najafgarh nallah (winter) and organic farm at Lady Irwin College, University of Delhi.

High levels of Cd was observed in gourd from Hindon floodplains (3.46 ppm). These levels were above the MPL of WHO; 0.2 ppm. Very high levels of Pb was detected from raddish leaves (0.532 ppm) from Hindon floodplains, cauliflower (0.4 ppm), spinach (1.58ppm) and raddish (0.76 ppm) in winter near Najafgarh nallah, spinach (0.43 ppm), and brinjal (2 ppm) from organic farm at Lady Irwin College, University of Delhi. These levels are higher than the permissible levels by WHO; 0.3 ppm.

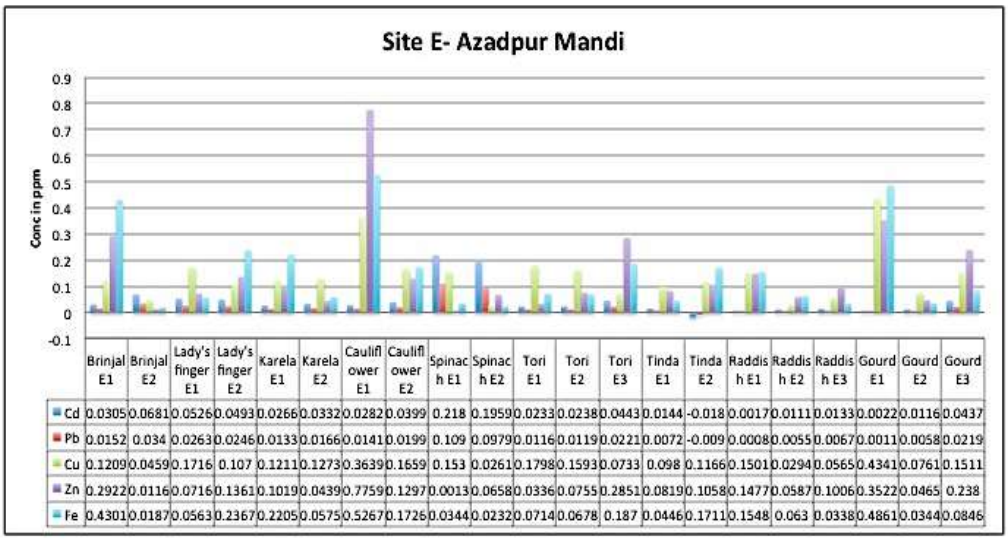
In all the vegetable crops, significant differences were found in heavy metal concentrations between the winter and summer cropping collected near Najafgarh nallah (figure 6). Heavy metal concentrations were higher in the vegetables harvested in the winter cropping season whereas during summer the vegetables had the concentration of metals below permissible level. The vegetables grown on organic farm of Lady Irwin College also showed high concentrations of heavy metals since organic farming is the way of farming and if the soil contains heavy metals, the plants will uptake and accumulate them.

The heavy metal content of vegetables collected from Azadpur mandi were within the permissible level of WHO (Fig 7). All the vegetables were washed with both warm and cold water. Washing did remove a considerable amount of heavy metals deposited on the surface of vegetables but no conclusive result could be formulated as to the best temperature of water.In most of the vegetables the uptake of metals was seen to be in the order Zn>Cu>Pb>Cd irrespective of the vegetable.



	Brinjal Najfgarh C1	Brinjal Najfgarh C2	Green Brinjal C1	Green Brinjal C2	Lady's finger C1	Lady's finger C2	Karela C1	Karela C2	Tori C1	Tori C2	Tori C3
Cd	0.0199	0.0249	0.08575	0.09295	0.1112	0.1444	0.03045	0.03985	0.026	0.03155	0.0321
Pb	0.0312	0.03445	0.0807	0.00215	0.06565	0.1367	0.0323	0.06565	0.05275	0.0237	0.0904
Cu	0.14675	0.0726	0.10925	0.10715	0.1577	0.3201	0.148	0.1419	0.14105	0.07885	0.1787
Zn	0.8229	0.0548	0.0806	0.07545	0.13285	0.0935	0.8339	0.12445	0.03675	0.02645	0.0477
Fe	1.14555	0.04125	0.06805	0.0578	0.27675	0.12015	1.2151	0.32765	0.03735	0.03615	0.0461

Figure 6: Various levels of heavy metals in vegetables collected near Najafgarh nallah during summer



	Brinjal E1	Brinjal E2	Lady's finger E1	Lady's finger E2	Karela E1	Karela E2	Caulifl ower E1	Caulifl ower E2	Spinac h E1	Spinac h E2	Tori E1	Tori E2	Tori E3	Tinda E1	Tinda E2	Raddis h E1	Raddis h E2	Raddis h E3	Gourd E1	Gourd E2	Gourd E3
Cd	0.0305	0.0681	0.0526	0.0493	0.0266	0.0332	0.0282	0.0399	0.218	0.1959	0.0233	0.0238	0.0443	0.0144	-0.018	0.0017	0.0111	0.0133	0.0022	0.0116	0.0437
Pb	0.0152	0.034	0.0263	0.0246	0.0133	0.0166	0.0141	0.0199	0.109	0.0979	0.0116	0.0119	0.0221	0.0072	-0.009	0.0008	0.0055	0.0067	0.0011	0.0058	0.0219
Cu	0.1209	0.0459	0.1716	0.107	0.1211	0.1273	0.3639	0.1659	0.153	0.0261	0.1798	0.1593	0.0733	0.098	0.1166	0.1501	0.0294	0.0565	0.4341	0.0761	0.1511
Zn	0.2922	0.0116	0.0716	0.1361	0.1019	0.0439	0.7759	0.1297	0.0013	0.0658	0.0336	0.0755	0.2851	0.0819	0.1058	0.1477	0.0587	0.1006	0.3522	0.0465	0.238
Fe	0.4301	0.0187	0.0563	0.2367	0.2205	0.0575	0.5267	0.1726	0.0344	0.0232	0.0714	0.0678	0.187	0.0446	0.1711	0.1548	0.063	0.0338	0.4861	0.0344	0.0846

Figure 7: The Cu, Zn, Cd and Pd contents in vegetables from Azadpur mandi (wholesale market for vegetables)

Bio-concentration factor- Bio-concentration factor (BCF) is commonly used toappraise the ability of a plant to uptake toxic elements from the soil.

$$BCF = \frac{\text{concentration of metal in vegetable}}{\text{concentration of metal in soil}}$$

a. Yamuna Floodplains	BCF (Cu)	BCF (Zn)	BCF (Cd)	BCF (Pb)
Brinjal	140.1520231	120.4063865	0.847399829	8.514211886
Gourd	88.79055877	149.9836245	0.342995169	7.640826873
Lady Finger	74.6734104	195.183952	0.112105712	0
Radish	27.72398844	87.15966157	0.232949702	0
Spinach	83.03208092	164.9274017	0.457800512	0.32751938

b. Hindon Floodplains	BCF (Cu)	BCF (Zn)	BCF (Cd)	BCF Pb)
Raddish leaves	310.4022617	40.67438782	7.63139357	5.329876837
Spinach	271.8885299	87.17124421	4.523667851	15.00846944
Brinjal	284.7374798	36.68696228	3.962100458	29.58702034
Cauliflower	297.4878837	12.76075447	40.11838322	0.335498937
Mint	267.3327948	12.76075447	2.087202529	32.09721191
Mustard leaf	139.8287561	66.99338187	6.524192714	8.38588326
Gourd	267.2011309	71.30013236	2.280920854	60.9102688

c. Najafgarh (winter)	BCF (Cu)	BCF (Zn)	BCF (Cd)	BCF (Pb)
Cauliflower	82.885	228.674	0.422	50.354
Spinach	226.734	412.932	0.668	209.814
Raddish leaves	153.026	201.622449	1.204	57.072
Raddish	216.022	359.617	12	85.605

d. Organic	BCF (Cu)	BCF (Zn)	BCF (Cd)	BCF (Pb)
Brinjal	35.096	75.252	0.785	12.629
Spinach	36.22	70.884	0.884	10.061
Raddish	21.165	83.999	0.919	17.767

Table 1 : The BCF values for various vegetables collected from the four sites.

The BCF values above 1.0 indicates higher uptake of heavy metals in vegetables than in the soil. An area which recorded BCF below 1.0 indicates high heavy metals concentration in soil in relation to vegetables and therefore low uptake of heavy metals to vegetables. The calculated BCFs for the heavy metals from different sites in Delhi-NCR region are presented in Table 1 (a-d). The BCFs of Cu, Pb and Zn for all vegetables and at all locations were found to be, in general, above one (1.0) Such high BCF values suggest that these vegetables should not be eaten raw. It is observed that the green vegetables accumulate greater concentration of heavy metals. The BCF values of summer vegetables collected

from Najafgarh was lower than 1.It is seen the accumulation of Zn from soil to vegetables is the highest followed by Cu>Pb>Cd.

Pesticide

Pesticides have different distribution and persistence patterns in the environment, even if all of them are distributed in some way through air, soil and water. This should be addressed to gain an understanding of how acute and chronic exposure may occur because air, water and soil are the media of exposure. When a pesticide is applied directly to a target pest (plant or animal) the whole site is affected including crop plants, soil organisms and, potentially, humans and wildlife in the immediate area. In addition, part of it goes to the air or to surface waters, due to emission or drift. Once on the target site, the pesticide may "drain" into surface waters or volatilize into the air. From the air it may deposit on humans, wildlife or plants or on the soil. From the animals or plants where it was applied the pesticide may leak into groundwater. The persistence of the pesticide depends on its physical and chemical properties (partition coefficients, degradation rates, deposition rates and the characteristics of the environment. The most persistent pesticides are termed “persistent organic pollutants” (POPs). Some pesticides are characterized by being very persistent in the environment. They may represent long-term dangers as they biomagnify up the food-chain. Humans, and particularly breastfed babies, are at the top of the food-chain. Organophosphates and carbamates can affect the nervous system. Others may irritate the skin or eyes. During the investigative study carried out the vegetables were found to be contaminated with pesticedes which have been classified as POPs under Stockholm Convention- aldrin, lindane and endosulfan. Some of these are carcinogens. Others affect hormones or endocrine system in the body.

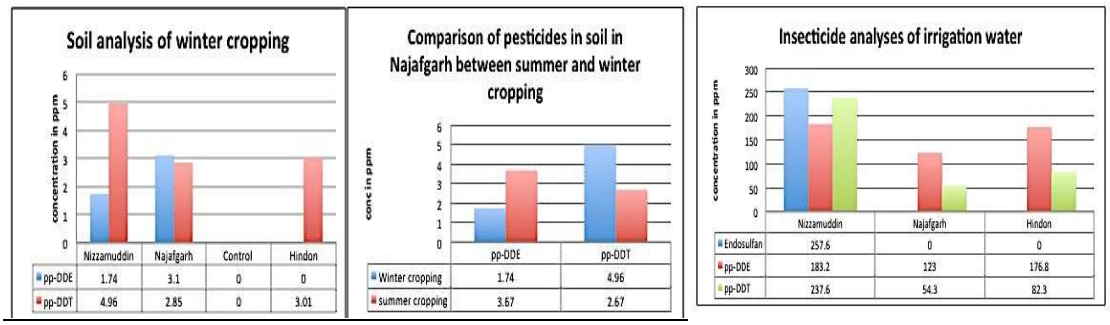


Figure 8- Levels of pesticide in soil and irrigation water collected from various sites

S. no.	Pesticide	CODEX (mg/kg)	*fssai* (mg/kg)
1.	Aldrin (POP)	0.05	0.1
2.	All Endosulfan (POP)	0.1	2
3.	Lindane (POP)	0.01	1
4.	DDT (POP)	0.2	3.5
5.	DDD (metabolite of DDT)	0.2	3.5
6.	Alachlor (Herbicide)	NA	NA
7.	d-BHC (isomer of HCH)	0.01	1
8.	Butachlor (Herbicide)	NA	NA

Table 2: The allowed levels pesticides in vegetables by CODEX (WHO/FAO) and *fssai*

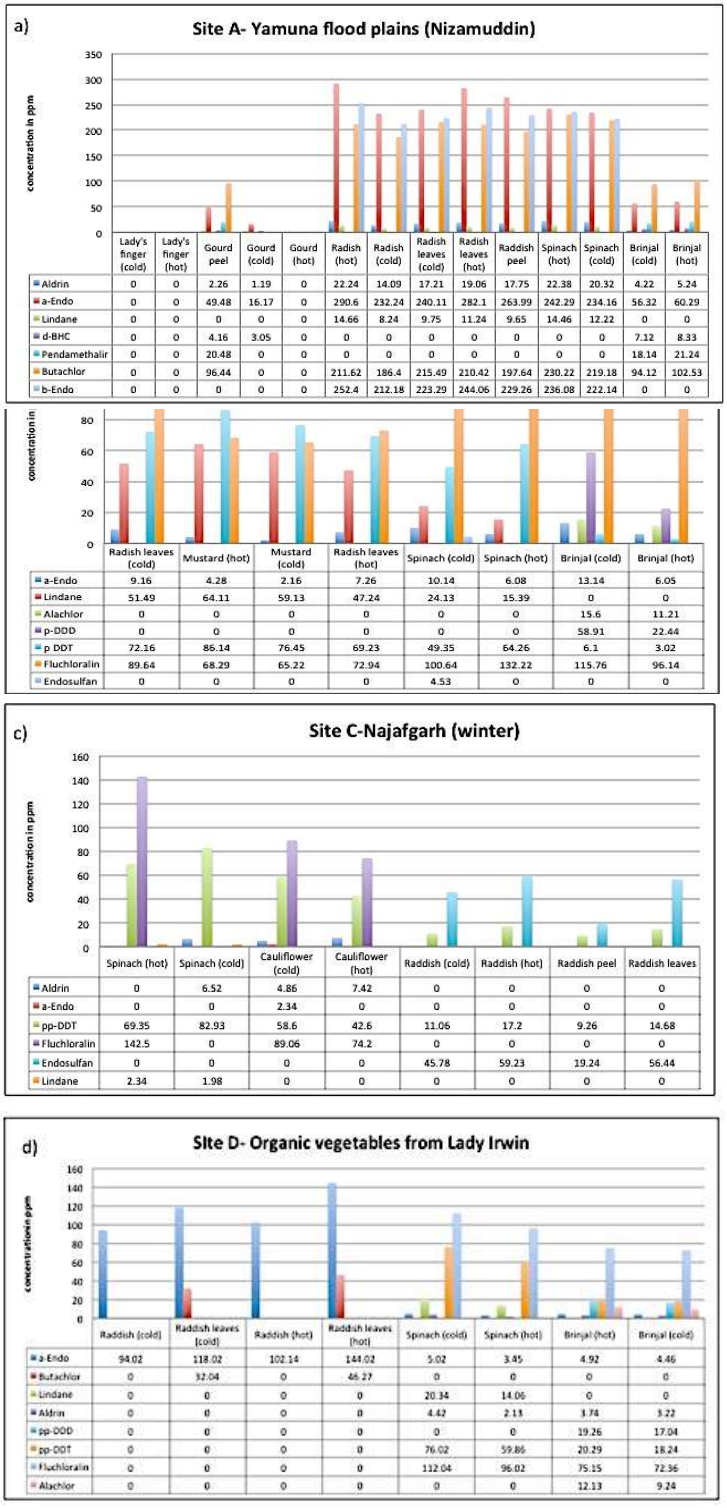
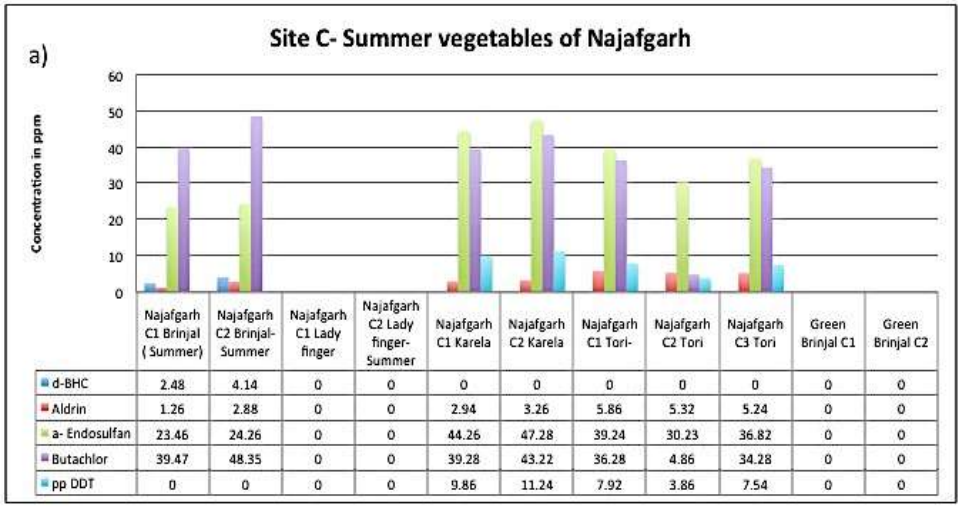
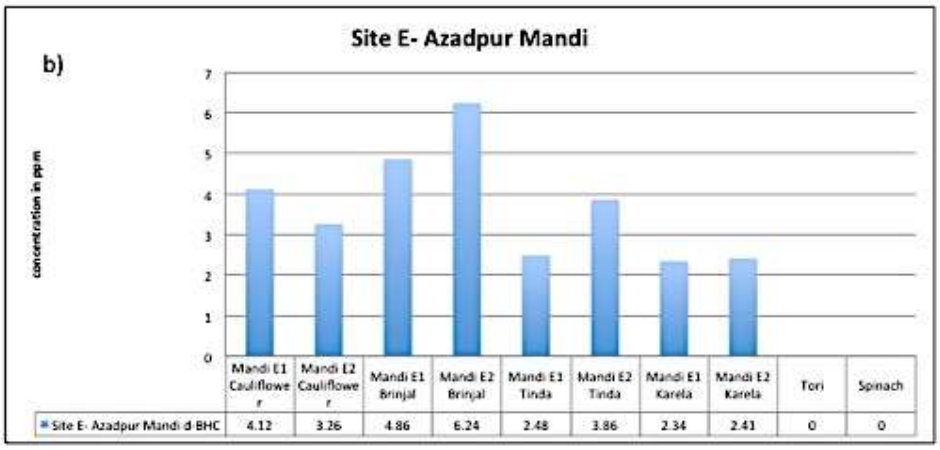


Figure 9: The levels in pesticide collected during winter season from the four sites.

The results of the study show high levels of pesticides collected from all sites (Fig 9).
Most of these pesticides included POPs like aldrin, endosulfan and lindane. An alarming feature observed was very high levels of pesticides in organic vegetables. They contained levels of endosulfan varying from 4.69 ppm in brinjal to as high as 131.02 ppm in radish leaves (Fig 11d). These values are above the permissible levels of CODEX- 0.1 ppm. Alarming levels of POPs lindane (17.2 ppm), aldrin (3.28 ppm) and DDT (67.85 ppm) were also observed in spinach. These are above the permissible levels by CODEX- 0.05 ppm, 0.01 ppm and 0.2 ppm of aldrin, lindane and DDT respectively. Since not much attention must have been paid to the surrounding areas these pesticides must have been transported through air or through surface water, due to emission or drift. That is why it is important to evaluate the surroundings before starting an organic farm.



	Najafgarh C1 Brinjal (Summer)	Najafgarh C2 Brinjal- Summer	Najafgarh C1 Lady finger	Najafgarh C2 Lady finger- Summer	Najafgarh C1 Karela	Najafgarh C2 Karela	Najafgarh C1 Tori-	Najafgarh C2 Tori	Najafgarh C3 Tori	Green Brinjal C1	Green Brinjal C2
d-BHC	2.48	4.14	0	0	0	0	0	0	0	0	0
Aldrin	1.26	2.88	0	0	2.94	3.26	5.86	5.32	5.24	0	0
a- Endosulfan	23.46	24.26	0	0	44.26	47.28	39.24	30.23	36.82	0	0
Butachlor	39.47	48.35	0	0	39.28	43.22	36.28	4.86	34.28	0	0
pp DDT	0	0	0	0	9.86	11.24	7.92	3.86	7.54	0	0



	Mandi E1 Cauliflower	Mandi E2 Cauliflower	Mandi E1 Brinjal	Mandi E2 Brinjal	Mandi E1 Tinda	Mandi E2 Tinda	Mandi E1 Karela	Mandi E2 Karela	Tori	Spinach
Site E- Azadpur Mandi d BHC	4.12	3.26	4.86	6.24	2.48	3.86	2.34	2.41	0	0

Figure 10: Levels of pesticides found in summer vegetables collected from Najafgarh and Azadpur Mandi.

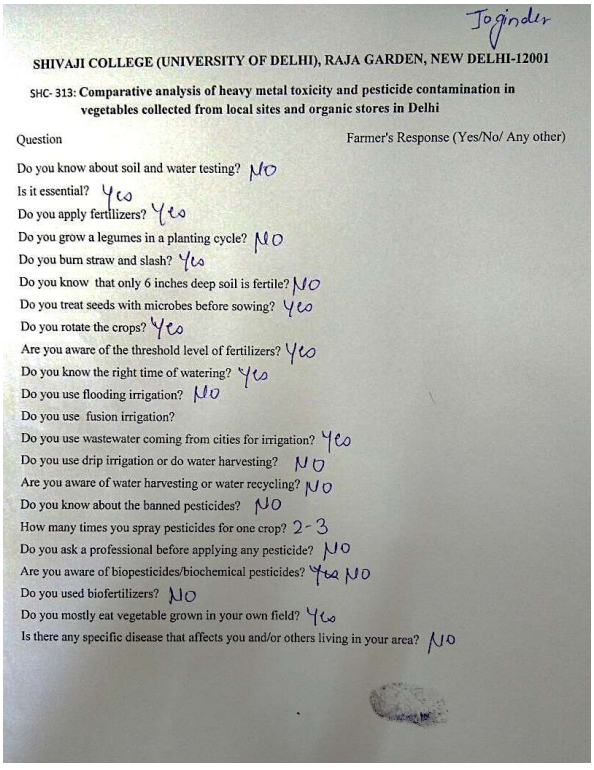
Pesticides levels in Najafgarh vegetables were lower than the winter vegetables but still above the CODEX permissible levels. The vegetables in Azadpur mandi contained high levels of d-HCH, an isomer of lindane, which deposits and accumulates in the adipose tissue of our body. It is not as toxic as lindane but since it keeps accumulating in the body it might have a long-term effect on the body.

8. Innovations shown by the project: Lab to land

On the basis of the alarming levels of heavy metals and pesticides detected in the vegetables collected from Najafgarh it was decided by the students and project investigators to hold a workshop 'Kisan Jagrukta Karyashala' in Najafgarh area on 28th September, 2016 to create awareness among the farmers of the current situation and educate them about the use of pesticides in correct amount. For this two of the well-known horticulturalists Prof. J.K. Nangal and Dr. Jitender Bamel were invited from Haryana Agricultural University. The team shared with them the findings of the project. They were educated of the right amount of pesticides that should be sprayed. Moreover they were made aware of the health implications of the heavy metals and pesticides in vegetables, which are also consumed by their family members. The workshop was a much success and gained much media coverage.

The team

Farmers were asked some basic questions regarding their knowledge about use of pesticides and presence of heavy metals in soil, water and the vegetable they grow. their response through a questionaire indicate their ignorance towards some very simple but important issues. Forty farmers from Najabgarh area villages were the subjects. Some filled questionaires are as follows:



Jogindar

SHIVAJI COLLEGE (UNIVERSITY OF DELHI), RAJA GARDEN, NEW DELHI-12001

SHC- 313: **Comparative analysis of heavy metal toxicity and pesticide contamination in vegetables collected from local sites and organic stores in Delhi**

Question	Farmer's Response (Yes/No/ Any other)
Do you know about soil and water testing?	NO
Is it essential?	Yes
Do you apply fertilizers?	Yes
Do you grow a legumes in a planting cycle?	NO
Do you burn straw and slash?	Yes
Do you know that only 6 inches deep soil is fertile?	NO
Do you treat seeds with microbes before sowing?	Yes
Do you rotate the crops?	Yes
Are you aware of the threshold level of fertilizers?	Yes
Do you know the right time of watering?	Yes
Do you use flooding irrigation?	NO
Do you use fusion irrigation?	
Do you use wastewater coming from cities for irrigation?	Yes
Do you use drip irrigation or do water harvesting?	NO
Are you aware of water harvesting or water recycling?	NO
Do you know about the banned pesticides?	NO
How many times you spray pesticides for one crop?	2-3
Do you ask a professional before applying any pesticide?	NO
Are you aware of biopesticides/biochemical pesticides?	Yes NO
Do you used biofertilizers?	NO
Do you mostly eat vegetable grown in your own field?	Yes
Is there any specific disease that affects you and/or others living in your area?	NO

9. Conclusion and Future direction

- The concentrations of the heavy metals in irrigation waters, and vegetables from Najfgarh area showed higher levels of pollution than those from other sites. As per CPCB, 2007, Najfgarh nallah is one of the major polluting drains of Delhi, carrying the wastewater from the industries.
- The distribution of the heavy metals in the plants grown on the polluted soils differed from plant to plant.
- Most edible parts of the vegetables from study areas are polluted with the heavy metals and pesticides, which include POPs like lindane, endosulfan and aldrin.
- Method of farming cannot screen the uptake of heavy metals by plants. If the irrigation water or soil contains heavy metal content the organic farm produce will have heavy metal contamination as seen in the results
- Before starting organic farming, the soil and irrigation water should be tested for pesticides. No one should be allowed to carryout farming with pesticides in the near perimeter of the organic farm as the pesticides can be transported by air.
- It is very important to raise the education level of farmers so that they judiciously use pesticides and understand the hazards of excessive usage of pesticides on environment and humans.
- The maximum permissible levels should be strictly followed and banned pesticides should not be used.
- Serious sensitization of the populace in the area Delhi- NCR is needed about the health implications of consuming such vegetable. living in Delhi that the vegetables grown locally have higher heavy metal and pesticides content thus vegetables should be bought from Azadpur mandi which have very low levels of pesticides and heavy metals.
- Regular check should be kept on the industries to ensure they treat the wastewater before discharging it in the water bodies.
- More number of sampling in different seasons is required to confirm the extent of contamination of the agricultural sites and vegetables.

10. References in APA format

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11. Publication/s from the work. (attach copies)

Nigam A., Bamel K., Malik, D. and Nijhawan, S. 2016. Heavy metal contamination in vegetables: Source of Nutrition or Health Hazard? *Journal of Basic and Applied Engineering Research,* Vol 3(1)

Bamel K., Nigam A. and Nijhawan S. 2016. Toxic effects of heavy metals on male reproductive health. Proceedings of National Seminar on Air and Water Quality in Urban Ecosystem, ISBN 978-93-5267-493-0 (in press).

12. Conference Presentation/s (attach copies)

Oral presentation

- Dr. Aeshna Nigam presented the paper 'Heavy Metal Contamination in Vegetables: Source of Nutrition or Health Hazard?' was presented at an International Health Conference held in Daulat Ram College, University of Delhi from 15-16th January, 2016 and was awarded the Best Oral Presenter Award
- Dr. Aeshna Nigam presented the paper on 'Toxic Effect of Heavy Metals on Reproductive Health of Women' at Environmental Concerns of 21st Century: Indian and Global Context' organized by Zakir Hussain Delhi College (Evening) on 21-22 March, 2016

Poster presentation

- Kiran Bamel, Aeshna Nigam and Shashi Nijhawan. Heavy metal contamination leading to lifestyle disorder'. Poster presented in National Symposium on Lifestyle Disorders (NSLD): Understanding the Molecular Mechanism held in Shivaji College, University of Delhi on 28th January 2016.

- Kiran Bamel, Aeshna Nigam and Shashi Nijhawan. Toxic effects of heavy metals on male reproductive health. Poster presented in National Seminar on Air and Water Quality in Urban Ecosystem organized by Eco Club of Shivaji College, University of Delhi on 22nd March, 2016.

- Himanshu, Shashank, Dr Aeshna Nigam, Dr Kiran Bamel and Dr Shashi Nijhawan 'Heavy Metal Toxicity in the Vegetables grown in Delhi and NCR region'. Poster presented at Innovation Conclave, Rajatotsav celebrations organized by Acharya Narendra Dev College University of Delhi from 25 - 26 October 2016.

- Shalu Dagar, Priyanka Kumari, Kiran Bamel, Aeshna Nigam and Shashi Nijhawan 'Vegetables Grown in Delhi and NCR region are intoxicated with Pesticides'. Poster presented at Innovation Conclave, Rajatotsav celebrations organized by Acharya Narendra Dev College University of Delhi from 25 - 26 October 2016.

13. Patent/s and Technology Transfer (attach copies)- nil

14. Media Coverage (attach copies)

Amar Ujala

अध्यापक-छात्रों का शोध, एनसीआर के खेतों में धातु, कीटनाशक का ज्यादा प्रयोग

अमर उजाला ब्यूरो

बहादुरगढ़।

शिवाजी कॉलेज दिल्ली के अध्यापकों और छात्रों के एक दल ने एक अभियान के तहत दिल्ली एनसीआर के खेतों में शोध किया। शोध में पाया गया कि एनसीआर क्षेत्र के खेतों में उगाई जा रही सब्जियों में कॉपर, जिंक, लैड और कीटनाशक का स्तर अनुमति से अधिक है।

प्रिंसिपल डॉ. शशि निशवान और डॉ. किरण बामल के मार्गदर्शन में बीएससी बॉटेनी और बीएससी बायो केमिस्ट्री के प्रियंका, शालू, पूजा, शशांक, हिमांशु, शिवानी, यामिनी, अमित, अभिषेक व अनिकेत आदि विद्यार्थियों ने शोध कार्य किया। यह शोध कार्य दिचाऊ, मिजाउ, सुखपुर, सिद्दीपुर और लोवा आदि गांवों में चला। शोध के दौरान हंडन नदी और नजफगढ़ नाले के पानी से सिंचाई की गई सब्जियों के नमूनों में ज्यादा मात्रा में धातु और कीटनाशक पाए गए। गांव सिद्दीपुर में आयोजित किसान जागरूकता कार्यशाला में किसानों को इस शोध और शोध के दौरान पाई गई खामियों के प्रति किसानों को जागरूक किया गया। हिसार कृषि विश्व विद्यालय के बागवानी विशेषज्ञ प्रो. नांदल ने कहा कि फसलों में धातु और कीटनाशक की अधिकता बेहद नुकसानदायक होती है, किसानों को इस पर थोड़ा ध्यान देना होगा। कीटनाशक का इस्तेमाल कम करने का सुझाव देते हुए प्रो. नांदल ने कहा ने किसानों को ऑर्गेनिक फार्मिंग और इंटरग्रेटिड पेस्ट मैनेजमेंट की जानकारी दी। किसानों ने भी कार्यशाला के आयोजन व शोध करने पर कॉलेज के स्टाफ और अध्यापकों को धन्यवाद किया।

बहादुरगढ़। सिद्दीपुर में किसानों को जागरूक करती वक्ता।

खुलासा : किसान जागरूकता शिविर में दिल्ली के शिवाजी कॉलेज के विद्यार्थियों ने किया खुलासा

Punjab Kesari

सावधानः नहीं हैं खाने लायक एनसीआर में उगाई जाने वाली सब्जी

सिद्दीपुर गांव मे शोधकर्ता छात्र गांव के किसानों के साथ। (छाया :प्रमोद)

बहादुरगढ़,(प्रेम शर्मा):दिल्ली के आसपास एनसीआर में उगाई जाने वाली सब्जियां खाने के लायक ही नहीं हैं क्योंकि यहां उगाईजाने वाली सब्जियों में भारी मात्रा में धातु एवं कीटनाशक की मात्रा ज्यादा होने से सब्जी खाने के लायक नहीं हैं। बहादुरगढ़ के गांव सिद्दीपुर में शिवाजी कालेज के ट्रेनेशन प्रोजेक्ट के अंतर्गत की गई शोध से यह खुलासा हुआ है। कालेज के प्रिंसीपल डा शशि निशवान, डा किरण बामल और डा रश्मी के मार्गदर्शन में बॉटनी और बायो केमिस्ट्री के छात्रों प्रियंका, शालू समसपुर खालसा, पूजा, शशांक कसार हिमांशु मांडौठी शिवानी, अमित, अभिषेक, ने जब एनसीआर के गांव सिद्दीपुर सहित कई अन्य गांव में शोध किया तो यह खुलासा मात्रा में धातु, शीशा, जिंक, क्लोराइड,आयनकेडमियम और कीटनाशक की भारी मात्रा पाई गई है। अपनी शोध को किसानों तक पहुंचाने के लिए शिवाली कालेज दिल्ली ने नजफगढ के नाले के आसपास मुंडेला,दिचाऊ, सुरखपुर सिद्दीपुर लोवा गांव के किसान के लिए किसान जागरुकता कार्यशाला को आयोजन गांव सिद्दीपुर में किया जिसमे हिसार कृषि विश्वविद्यालय के बागवानी विशेषज्ञ प्रो नांदल ने कीटनाशक और धातुओं के हानिकारक प्रभावो की जानकारी दी। लोवा सत्तरा के प्रधान चौधरी श्रीचंद मान श्री अमरसिंह चेयरमैन कैर और जयकिशन प्रधान सिद्दीपुर भी केम्प में शामिल रहे। सभी किसानों ने अपनी समस्या बताते हुए सिंचाई कीटनाशक और प्रदूषित जल और

Dainik Jagran

दूषित पानी से सिंचित सब्जी में मिले कीटनाशक

- किसानों को किया कम कीटनाशक का प्रयोग करने के लिए जागरूक
- जैविक खेती पर दिया बल

बहादुरगढ़ गांव सिद्दीपुर लोवा में किसान जागरूकता कार्यक्रम में गौतम कॉलेज के विद्यार्थी व किसान।

कीटनाशकों के इस्तेमाल से बचें किसान

15. Pictures related to the project.

Sample collection

Interaction with Mentor

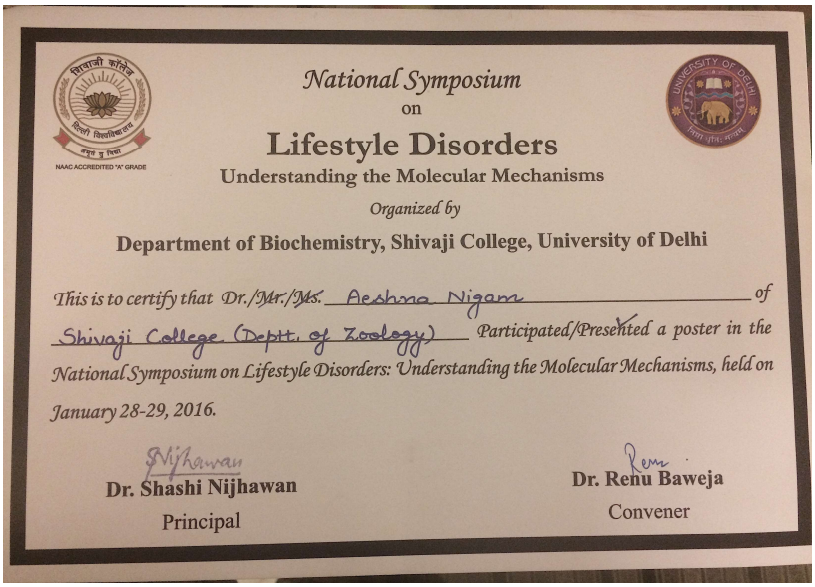
Yamuna river

Students at work

Najafgarh nallah

Hindon River

16. Annexure/Any other information- Certificate of participation

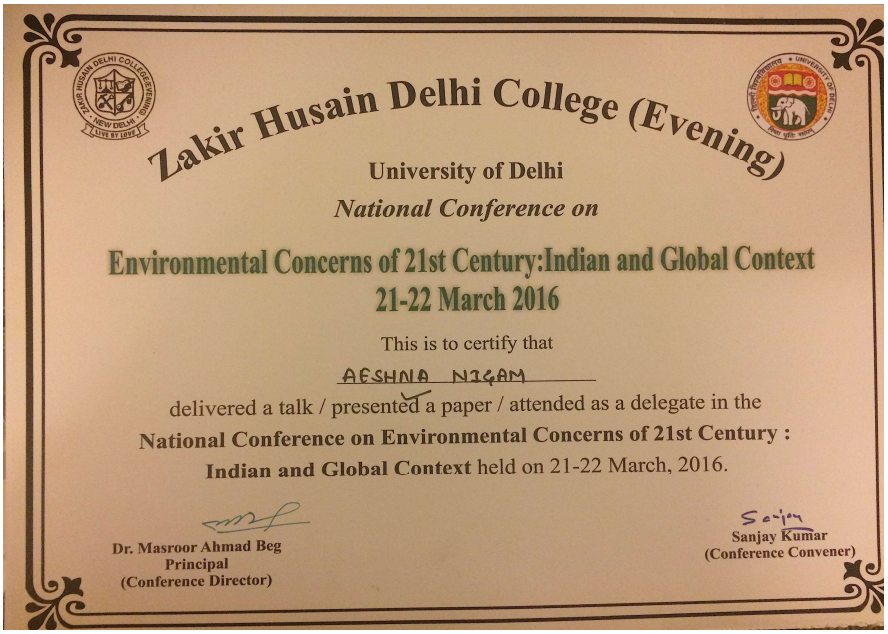


National Symposium
on
Lifestyle Disorders
Understanding the Molecular Mechanisms
Organized by
Department of Biochemistry, Shivaji College, University of Delhi

This is to certify that Dr./Mr./Ms. Aeshna Nigam of Shivaji College (Deptt. of Zoology) Participated/Presented a poster in the National Symposium on Lifestyle Disorders: Understanding the Molecular Mechanisms, held on January 28-29, 2016.

Dr. Shashi Nijhawan
Principal

Dr. Renu Baweja
Convener



Zakir Husain Delhi College (Evening)
University of Delhi
National Conference on
Environmental Concerns of 21st Century:Indian and Global Context
21-22 March 2016

This is to certify that
AESHNA NIGAM
delivered a talk / presented a paper / attended as a delegate in the
National Conference on Environmental Concerns of 21st Century :
Indian and Global Context held on 21-22 March, 2016.

Dr. Masroor Ahmad Beg
Principal
(Conference Director)

Sanjay Kumar
(Conference Convener)

International Conference

On

Public Health: Issues, Challenges, Opportunities, Prevention, Awareness
(Public Health: 2016)

Organized by

Daulat Ram College, University of Delhi, New Delhi, India *and*
Krishi Sanskriti, New Delhi, India

On

15th and 16th January, 2016

Research Paper Oral Presentation / Contribution Certificate

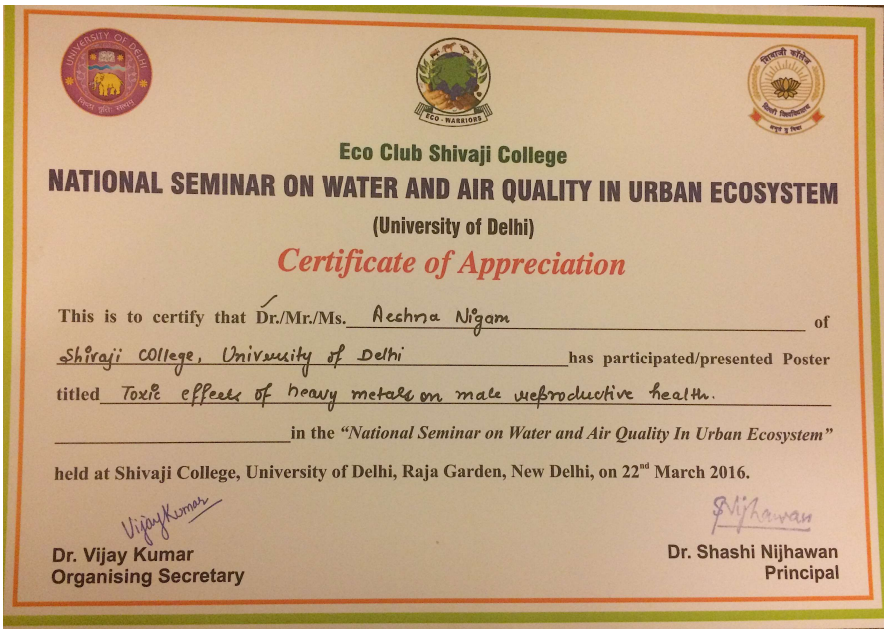
Certified that Prof./Dr./ Mr./Mrs./Ms Aeshna Nigam of
was awarded "Best Speaker" award Presented/Contributed a Research Pape
titled Heavy Metal Contamination in Vegetables : Source of Nutrition or Health
Hazard ?
Authored by Dr. Aeshna Nigam
in two days International Conference held in Daulat Ram College, University of Delhi, New Delhi, India

Dr. G.C. Mishra
President Krishi Sanskriti
Organizing Secretary

Dr. Savita Roy
Principal
Daulat Ram College
Chair Person

Dr. Sarita Nanda
Associate Professor
Dept. of Biochemistry
Convener

Dr Anju Jain
Assistant Profess
Dept. of Zoology
Co-Convener



Eco Club Shivaji College

NATIONAL SEMINAR ON WATER AND AIR QUALITY IN URBAN ECOSYSTEM

(University of Delhi)

Certificate of Appreciation

This is to certify that Dr./Mr./Ms. Aeshna Nigam of
Shivaji College, University of Delhi has participated/presented Poster
titled Toxic effects of heavy metals on male reproductive health.
in the *"National Seminar on Water and Air Quality In Urban Ecosystem"*
held at Shivaji College, University of Delhi, Raja Garden, New Delhi, on 22nd March 2016.

Dr. Vijay Kumar
Organising Secretary

Dr. Shashi Nijhawan
Principal

National Symposium

on

Lifestyle Disorders

Understanding the Molecular Mechanisms

Organized by

Department of Biochemistry, Shivaji College, University of Delhi

This is to certify that Dr./Mr./Ms. Kiran Bamel *of*
Shivaji College (Deptt. of Botany) *Participated/Presented a poster in the*
National Symposium on Lifestyle Disorders: Understanding the Molecular Mechanisms, held on
January 28-29, 2016.

Dr. Shashi Nijhawan
Principal

Dr. Renu Baweja
Convener

ACHARYA NARENDRA DEV COLLEGE
25 YEARS 1991 - 2016

Acharya Narendra Dev College
University of Delhi
rajatotsav
Silver Jubilee Celebrations

Innovation Conclave – 2016
Nurturing Research at the UG Level

Certificate of Participation

This is to certify that Mr. Himanshu Dalal of Shivaji College has presented a poster in the Innovation Conclave-2016 organised by Acharya Narendra Dev College (University of Delhi) under the aegis of ANDC Silver Jubilee celebrations RAJATOTSAV during October 25-26, 2016.

(Dr.Arijit Chowdhuri)
Convenor

(Dr. Savithri Singh)
Principal

October 26, 2016

Govindpuri, Kalkaji, New Delhi 110019 | http://andcollege.du.ac.in

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Innovation Conclave – 2016
Nurturing Research at the UG Level

Certificate of Participation

This is to certify that Ms. Shalu Dagar of Shivaji College has presented a poster in the Innovation Conclave-2016 organised by Acharya Narendra Dev College (University of Delhi) under the aegis of ANDC Silver Jubilee celebrations RAJATOTSAV during October 25-26, 2016.

(Dr.Arijit Chowdhuri)
Convenor

(Dr. Savithri Singh)
Principal

October 26, 2016

Govindpuri, Kalkaji, New Delhi 110019 | http://andcollege.du.ac.in

Utilization Certificate

Innovation Project 2015-16
SHC – 313

Project Title: Comparative Analysis of Heavy Metal Toxicity and Pesticide Contamination in Vegetables Collected from Local Sites and Organic Stores in Delhi

Audited Financial Statement under Innovation Project scheme

College: Shivaji College

Project Investigators: Dr. Shashi Nijhawan, Dr. Kiran Bamel, Dr. Aeshna Nigam

Grant Sanctioned Rs	Rs. 6,00,000/- (Rupees Six Lacs Only)		
	Grant Received	**Grant Utilized**	**Unspent Grant**
Equipments/Consumables	3,25,000/-	3,71,135/-	(46135)
Travel	55,000/-	8,148/-	46,852/-
Stipend	1,20,000/-	1,17,000/-	3,000/-
Honorarium	25,000/-	25,000/-	NIL
Stationery	20,000/-	20,489/-	(489)
Contingency	55,000/-	51,705/-	3,295/-
Total	**6,00,000/-**	**593,477/-**	**6,523/-**
Total amount utilized	Rs. 5,93,477/- (Rupees Five Lacs Ninety Three Thousand Four hundred Seventy Seven Only)		
Amount remaining Rs. (In figures and words)	Rs. 6,523/- (Rupees Six Thousand Five Hundred Twenty Three Only)		

Certified that out of **Rs. 6,00,000/- (Rupees Six Lacs Only)** sanctioned to Innovation Project Code **SHC-313, Rs. 5,93,477/- (Rupees Five Lacs Ninety Three Thousand Four hundred Seventy Seven Only)** has been utilized during the period of the project. The remaining amount **Rs. 6,523/- (Rupees Six Thousand Five Hundred Twenty Three Only)** and is being returned back to the University.

Note : Over expenditure under the head "Equipment/ Consumables has been met from unspent balance in Travel with prior approval from the Innovation Desk.

(Dr. Shashi Nijhawan)

(Dr. Kiran Bamel)

(Dr. Aeshna Nigam)

Principal

VIPUL DHAWAN & ASSOCIATES
Chartered Accountants
No. 518146
NEW DELHI