

Effect of pesticide residues on health and blood parameters of farm workers from rural Gadap, Karachi, Pakistan

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Abstract: The samples were collected from 83 persons on 1 day (reading-I), 7 days (reading-II) and 30 days (reading-III) engaged in pesticide spraying in fourteen different fruit and vegetable farm stations located in the orchards of Gadap (rural area), Karachi-Pakistan. In the present study, 26 workers out of 83 who were exposed to different pesticides (i.e., cypermethrin, deltamethrin, polytrin-C, diazinon, monocrotophos, DDT and DDE) were compared with 25 healthy control persons. Different blood parameters were determined in comparison to control subjects. The results indicate some alterations in blood indices in all the pesticide exposed persons, and only two persons from two different stations were affected severely and therefore their Hb, MCV, MCHC, TLC, monocyte and neutrophil counts increased significantly. High lymphocyte count was noted in almost all the exposed persons. Platelets count was also found high in few persons but Hb, MCV, MCH, TLC, RBC and neutrophil counts significantly decreased in such persons. Exposure of multiple pesticides for prolong period has also affected the health of exposed persons and produced dermatological, hepatic, nephritic, respiratory and other clinical disorders reflecting the toxic effects of pesticides. Our findings indicate that indiscriminate use of pesticides in farming environments must be regularly assessed and farm workers must be trained for safe use of pesticides.

Key words: Pesticides, Residues, Blood parameters, Health
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Introduction

There is no doubt that some persistent pesticides accumulate in various biological systems at levels much higher than those in their surroundings. There are three major routes of the transport of pesticides within the body that may be through leaching water, aerial contamination and accidental or professional exposure.

Pakistan is an agricultural country with population of about 160 millions. However, 70% of the population lives in villages and mostly involved in agriculture directly or indirectly. The farmers to save their crops from pest attack and to increase the per acre yield of various commodities, use synthetic pesticides which are costly and hazardous. These synthetic pesticides are causing various problems e.g., pesticidal pollution, resistance in pests and accumulation of pesticidal residues in the body of animals and human beings. Due to the lack of knowledge, indiscriminate use and malpractices adopted by the spray men, hazardous effects on their health are observed.

For this reason the developed countries have diverted their attention towards IPM program (Integrated Pest Management), and they are now using phytopesticides and hormonal pesticides instead of synthetic pesticides to avoid their hazardous effect on human health. Among many problems, we have been facing in Pakistan is the pollution. Therefore, to assess any risk to human health by their extensive use and adaptation of many malpractices

during spraying of pesticides by the spray men, their effects on health and different blood parameters have been determined during the present work.

Many research publications appear each year on pesticidal residues, resistance and pollution. Simcox *et al.* (1995) reported the exposure pathways of pesticides in the household dust and soil for children of agricultural families in eastern Washington State. Joshi *et al.* (1996) also mentioned the effect of hexachlorocyclo-hexane (HCH) exposure in the body of 260 spray men as test subject and 50 persons as controls from sprayed and unsprayed villages during the community-based study in Allahabad district, Uttar Pradesh, India. Luo *et al.* (1997) reported the determination of DDT and DDE levels in the serum of general population in Singapore by gas chromatography using PTE-5 capillary column method. In Pakistan, Naqvi and Jahan (1999), Azmi *et al.* (2005) determined the presence of pesticide residues in the blood of Karachi people. Presence of pesticide residues in human blood and water was also determined by other researchers (Ntow, 2001; Charlier and Plomteux, 2002; Musshoff *et al.*, 2002; Butler *et al.*, 2003; Van Oostdam *et al.*, 2004; Lino and Silveira, 2006; Zafer, 2007). Lopez *et al.* (2007) determined organochlorine pesticide and also polychlorinated biphenyls in human serum using headspace solid-phase microextraction and gas chromatography-electron capture detection method.

Correlation of different blood parameters with the harmful effects of pesticides especially in the case of total leukocyte count

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(TLC), red cell count, hemoglobin content, hematocrit, MCV, MCH, MCHC and platelet count has been reported by many researchers. (Srivastava *et al.*, 1991; Mythilai, 2000; Lee *et al.*, 2002; Corsini *et al.*, 2005). Much work has been done in many countries on pesticide-blood parameter correlation. However, such comprehensive work particularly on pesticide-blood parameter correlation ship has not been done in humans earlier in Pakistan. Therefore, analysis of blood samples of workers from different fruit and vegetable farm stations in the surroundings of Gadap area, Karachi was done to find any correlation between different blood parameters and the harmful effects of pesticides on them.

Materials and Methods

Collection and analysis of blood samples: Fourteen different fruit and vegetable farm stations were selected for this work. The blood samples obtained from different persons were processed and cleaned for pesticide determination by using the technique of Dale *et al.* (1970). 10 ml of each sample was injected by special chromatographic syringe in the HPLC (Schimadzu LC-3A). Further procedure as per Azmi *et al.* (2005) was followed.

Initially the detailed information regarding the health status or case history have been collected from each workers (exposed and unexposed) on a proforma. All the affected persons were examined and advised to check their health regularly. On that basis, their health parameters were assessed and obtained.

Blood samples collected from 25 normal persons (not exposed to pesticides *i.e.* control subjects) were brought to the laboratory. Sera was immediately proposed after centrifugation for hematological and pesticide residue analysis. The hematological analysis was done (Gottmann, 1968) using automated hematological analyzer aontrol T-series.

Differential leukocyte count (DLC) was also performed manually by making a blood smear stained with Leishman's stain which is based on Mukherjee (1995) method. The percentage of each type of leukocytes were their calculated under oil immersion objective lens.

Results and Discussion

The present work showed that total 247 (2 samples were not received) samples were taken from 83 persons on 1, 7 and 30 days (exposed to pesticides) and 25 normal control persons for the determination of pesticide residues and different blood parameter levels (Tables 1a,b, 2). Those which had high levels of pesticide residues were taken into consideration for finding the possible correlation between the residual levels and blood parameters. The different blood levels that were determined in the blood of selected workers (exposed to different pesticides) from 14 different farm stations are listed in Table 1a,b. Out of these 247, 78 samples from

14 stations had higher amount of residues. Regarding blood parameters, only 26 persons had significant variation possibly due to the cumulative effect of residues. In such case sample 1 from Station 1 had high limits of Hb content, TLC and neutrophil counts. In addition low level of lymphocyte and monocyte counts were also noticed possibly due to the prolonged exposure of pesticides such as cypermethrin ($\uparrow 8.95 \mu\text{g ml}^{-1}$) and DDE ($\uparrow 11.39 \mu\text{g ml}^{-1}$). Samples 5, 7, 8 and 11 from the same Station 1 also showed the alteration in their different blood parameters (Table 1a,b). Sample 2 from Station 2 had high basophils, lymphocytes, 7% band form and 3% metamyelocyte. This worker also showed low neutrophil count, RBC count, Hb concentration and hematocrit (Tables 1a,b), possibly due to the exposure of number of pesticides such as cypermethrin ($\uparrow 4.93 \mu\text{g ml}^{-1}$), monocrotophos ($\uparrow 35.40 \mu\text{g ml}^{-1}$) and DDE ($\uparrow 11.40 \mu\text{g ml}^{-1}$) simultaneously.

High lymphocyte count was found in almost all the exposed persons from different farm stations. Platelet count was found low in almost all the exposed cases, only few persons showed high platelet counts in some stations due to the frequent and direct exposure of pesticides during their working time. But their Hb content, hematocrit, MCV, MCH, RBC and neutrophil counts were found in low levels in such persons. Variation in different blood parameters may be due to cumulative effect of pesticide residues. Similar effects were also reported by many researchers (Kossmann *et al.*, 1993; Sahin *et al.*, 2002; Yousef *et al.*, 2003; Tokarska-Rodak *et al.*, 2004).

Concerning the test hypothesis for the blood parameters, the data was analyzed by analysis of variance technique by Generalized Linear Model (GLM) approaching (computer software Minitab-1982) to find the significant difference of blood parameters in different stations and different time period in comparison to control or unexposed persons according to Rayan *et al.* (1982), Walpole *et al.* (1998). The analysis given in Table 3 indicated the calculated values of F-statistics which are 0.05, 1514.00 and 3.92 with p-values 0.954, 0.000 and 0.000, respectively. So we conclude that there is significant difference in blood parameters at 14 stations.

It was observed that some of the blood parameters levels were highly affected by the presence of pesticide residues in their blood. For example, sample 1 from Station 1 was exposed to pesticides during spraying time with cypermethrin and DDE and showed high limits of TLC, Hb, Neutrophils and MCV in addition to low lymphocyte and monocyte counts. Therefore this person suffered with jaundice, toxic granulation, reactive neutrophilic Leukocytosis and macrocytic anemia. He also complained about the symptoms of itching, skin irritation and burning sensation in eyes or face, history of headache and backache during the working time. Similar finding was also reported by Safi *et al.* (2005). Also samples such as 3, 1, 4 and 5 from stations 10, 11, 12 and 13 respectively, showed some what similar effects on blood parameters such as high eosinophil,

Table - 1a: Effect of pesticide residues on health and different blood parameter in the effected person from different farm stations

St. No. / Sample No.	Pesticide residues ($\mu\text{g ml}^{-1}$)	Related health hazards	Read- ings	Blood parameters									
				TLC	RBC	Hb	Hct	MCV	MCH	MCHC	Pit		
Male = 19 (17-52 years)													
1/1	Cyper $\uparrow 8.95$ (I) $\uparrow 11.39$ (II)	DDE	- Jaundice(5 yr back) - Headache Backache - Toxic granulation - Reactive neutrophilic leukocytosis	I	$\uparrow 11.5$	5.47	$\uparrow 16.8$	48.5	88.6	30.6	34.6	241	
				II	$\uparrow 11.3$	5.47	$\uparrow 16.9$	48.5	88.6	30.6	34.6	233	
				III	$\uparrow 11.2$	5.49	$\uparrow 17.1$	48.1	88.2	30.2	34.2	238	
1/5	Cyper $\uparrow 9.13$ (II) 3.65 (III) DDT 3.70 (I) 3.70 (II)	Dia $\uparrow 5.40$ (II)	Mono $\uparrow 6.0$ (II)	- Jaundice(6 months back) - Headache Backache	I	4.2	<u>4.45</u>	13.2	40.1	90.2	23.8	33.0	222
					II	4.2	5.33	13.5	41.8	78.6	<u>25.4</u>	32.3	<u>147</u>
		DDE	- Joint pain - Chest pain during work - Nausea	III	4.0	<u>4.02</u>	<u>11.6</u>	<u>35.8</u>	89.0	28.8	32.4	159	
1/9	DDE <u>2.64</u> (I)			- Some time headache - No specific illness	I	9.1	5.27	15.6	45.6	86.5	29.6	34.2	240
					II	9.8	5.13	14.0	43.1	84.1	27.3	32.5	182
					III	9.3	5.10	<u>12.5</u>	<u>37.9</u>	<u>74.2</u>	<u>24.4</u>	32.9	186
1/10	Dia <u>2.64</u> (I)			- Nausea (sometimes) - No specific illness	I	4.8	5.33	13.5	41.8	78.6	<u>25.4</u>	32.3	187
					II	4.2	<u>4.45</u>	<u>13.2</u>	40.1	90.2	29.8	33.0	192
					III	4.3	4.99	14.2	42.4	85.1	28.5	33.4	201
1/11	Cyper $\uparrow 6.39$ (I) $\uparrow 5.11$ (II)	Mono <u>2.60</u> (II)	DDT 0.49(II)	- Headache - Feel lethargic - Backache	I	6.2	<u>3.96</u>	<u>8.7</u>	<u>28.6</u>	<u>72.3</u>	<u>22.1</u>	30.5	210
					II	6.3	<u>3.98</u>	<u>11.5</u>	<u>34.5</u>	86.7	28.9	33.3	221
					III	6.1	<u>3.81</u>	<u>12.1</u>	<u>34.9</u>	91.7	31.9	34.8	216
1/13	Cyper <u>1.68</u> (II) 0.31(III)	DDT 0.28(II)	Delta 0.41(III)	- Pneumonatic symptoms - Dyspnea - Feel sedation - Numbness of limbs - Nausea	I	7.0	4.52	15.4	43.9	$\uparrow 97.1$	$\uparrow 34.2$	35.2	153
					II	7.2	5.13	14.0	43.1	84.1	27.3	32.5	185
					III	7.1	5.13	14.0	43.1	84.1	27.3	32.5	182
1/16	Cyper 0.19(I)		Delta 0.55(I)	- No specific illness complained	I	6.2	4.85	14.4	41.6	85.7	29.7	34.6	172
					II	6.3	4.68	14.6	43.8	93.6	31.3	33.4	179
					III	6.1	4.40	14.2	42.5	$\uparrow 96.6$	$\uparrow 32.4$	33.5	181
1/20	Mono $\uparrow 4.03$ (II)	DDT 0.48(II)	DDE 0.67(II)	- No specific illness complained	I	5.3	4.73	<u>12.1</u>	<u>36.3</u>	76.8	<u>25.6</u>	33.3	286
					II	5.4	4.66	<u>13.2</u>	<u>38.7</u>	83.0	28.3	34.1	281
					III	5.2	4.50	<u>13.2</u>	42.0	93.3	29.3	31.4	276
2/2	Cyper <u>4.20</u> (II)	Mono 35.40(II)	DDE $\uparrow 11.40$ (II)	- Respiratory dyscomfort - Chest pain Pneumonatic attack (6 month back) - Joint pain - Abdominal discomfort	I	5.4	<u>4.02</u>	<u>13.1</u>	<u>38.5</u>	95.7	$\uparrow 32.5$	34.0	166
					II	5.3	4.66	<u>13.2</u>	<u>38.7</u>	83.0	28.3	34.1	185
					III	5.4	4.63	<u>13.5</u>	<u>38.8</u>	84.1	28.5	34.3	193
3/7	Cyper $\uparrow 7.94$ (III)			- Complained joint pain	I	6.2	5.57	13.9	42.1	78.9	<u>25.7</u>	32.7	197
					II	6.4	4.50	<u>13.2</u>	42.0	93.3	29.3	31.4	202
					III	6.3	5.20	<u>13.1</u>	41.4	78.2	<u>25.0</u>	31.8	215
4/2	Cyper $\uparrow 16.80$ (I)			- Jaundice (5-6 months back) - Headache - Lethargic during working	I	5.1	<u>3.72</u>	<u>12.1</u>	<u>37.0</u>	$\uparrow 99.6$	$\uparrow 32.5$	32.6	173
					II	$\uparrow 12.5$	<u>3.94</u>	13.7	36.1	91.7	$\uparrow 34.9$	$\uparrow 38.0$	188
					III	$\uparrow 11.5$	<u>3.81</u>	<u>11.5</u>	34.7	91.2	30.3	33.0	191

5/1	Cyper <u>4.47(I)</u>	DDE 4.22(I)	- No specific illness complained	I	3.9	5.02	14.8	43.3	86.4	29.4	34.1	310
				II	<u>4.5</u>	4.99	14.2	42.4	85.1	28.5	33.4	341
				III	4.9	<u>4.42</u>	14.4	42.7	↑96.8	↑32.6	33.7	321
7/1	Cyper ↑14.30(I) ↑17.80(III)	DDT 3.24(II)	- Jaundice (10 months back) - Headache sometimes - No specific illness complained	I	7.4	<u>4.37</u>	<u>12.6</u>	39.1	89.5	28.9	32.3	196
				II	7.5	4.99	14.2	42.4	85.1	28.5	33.4	201
				III	7.4	<u>4.40</u>	14.2	42.5	↑96.6	↑32.4	33.5	199
7/2	Mono ↑11.20(I) DDE ↑1420(III)	DDT 0.91(III)	- Jaundice (5 yr back) - No specific illness complained	I	7.2	4.50	<u>13.2</u>	42.0	93.3	29.3	31.4	240
				II	7.6	<u>4.39</u>	<u>12.9</u>	39.4	89.7	29.1	32.6	250
				III	7.5	<u>4.45</u>	<u>12.6</u>	36.3	81.8	28.1	34.5	237
8/1	Cyper ↑29.40(I) ↑8.58(II)	Mono ↑29.70(III)	- Nausea - RTI - Vomiting - Joint pain - Jaundice (1 yr back)	I	4.2	<u>4.45</u>	<u>13.2</u>	40.1	90.2	29.8	33.0	222
				II	4.1	<u>4.16</u>	13.5	38.4	92.2	↑32.3	↑35.1	224
				III	4.2	<u>4.41</u>	<u>13.3</u>	40.0	90.1	29.6	33.2	221
9/5	Cyper ↑17.80(II) Mono- 29.60(II) ↑34.00(III)	Dia ↑15.80(I)	- Complained kidney dysfunction - Burning sensation in urine	I	8.1	4.68	14.6	43.8	93.6	31.3	33.4	↑405
				II	8.1	4.69	14.4	43.7	93.5	31.2	33.3	↑406
				III	8.0	4.63	14.1	43.3	93.1	31.1	33.0	↑402
11/1	Cyper ↑11.32(I) 1.10(II) 0.63(III) DDE ↑41.30(III)	DDT ↑11.70(III)	- Jaundice(7-8 months back) - 8 months back - Vomiting and nausea usually - Dyspnea at working time - Joint pain - Feel discomfort	I	6.0	<u>3.92</u>	<u>12.2</u>	<u>36.4</u>	93.0	31.2	33.5	247
				II	6.1	<u>3.91</u>	<u>12.1</u>	<u>36.2</u>	92.8	31.3	33.7	246
				III	6.1	<u>3.93</u>	<u>12.2</u>	<u>36.1</u>	92.6	31.2	33.5	244
12/4	Cyper <u>2.37(I)</u> ↑26.40(II) ↑11.50(III) DDE ↑41.30(III)	Dia 28.80(II)	- Jaundice (6 months back) - Backache - Difficulty in breathing - Joint pain frequently	I	7.1	4.50	15.4	43.6	↑97.0	↑34.2	35.2	153
				II	7.1	<u>4.48</u>	15.0	43.4	↑96.8	↑34.1	35.1	151
				III	7.2	4.50	15.3	43.4	↑97.1	↑34.1	35.3	154
13/5	Cyper ↑12.10(I) ↑15.00(II) ↑5.20(III) Dia ↑6.12(III) DDT <u>3.98(III)</u>	Delta 3.18(III) Mono 1.32(II) DDT ↑13.70(III)	- Jaundice (6 months back) - Dyspnea - Cyanosis - Vomiting - Feel headache feel gerealweakness at working time	I	4.2	<u>3.65</u>	<u>10.6</u>	<u>31.0</u>	85.0	29.0	34.1	116
				II	4.2	<u>3.25</u>	<u>10.7</u>	<u>32.2</u>	↑100.5	↑32.6	32.4	117
				III	4.2	<u>3.45</u>	<u>10.8</u>	<u>32.6</u>	↑100.7	↑32.8	32.7	115
Female = 7 (28-60 years)												
1/7	Dia <u>3.96(I)</u>	DDE ↑6.33(II)	- No specific illness complained	I	6.0	<u>3.92</u>	12.2	<u>36.4</u>	93.0	33.5	33.5	247
				II	6.2	<u>3.96</u>	<u>8.7</u>	<u>28.6</u>	<u>72.3</u>	<u>22.1</u>	30.5	212
				III	6.2	<u>3.96</u>	<u>8.7</u>	<u>28.5</u>	<u>72.3</u>	<u>22.1</u>	30.5	212
1/8	Dia <u>3.96(I)</u>	DDE ↑6.33(II)	No specific illness complained	I	5.5	5.36	12.4	40.1	80.2	<u>25.1</u>	32.4	157
				II	5.4	4.73	12.1	<u>36.3</u>	76.8	<u>25.6</u>	33.3	176
				III	5.3	4.99	<u>10.9</u>	<u>33.4</u>	<u>67.0</u>	<u>21.9</u>	32.7	256

3/6	Mono ↑9.6(I)		- Jaundice (10 yr back) - No specific illness	I	5.3	<u>4.30</u>	12.9	38.4	89.7	29.9	33.6	196
				II	5.5	<u>4.38</u>	13.8	41.6	↑96.1	32.0	33.1	201
				III	5.1	<u>4.23</u>	12.3	<u>36.0</u>	85.3	29.1	34.1	206
7/4	Cyper 0.64(I) ↑15.9(II) DDT <u>4.98</u> (III)	Prof ↑65.50(III)	- Jaundice(4 months back) - chest pain (during working) - General weakness	I	4.5	<u>2.86</u>	<u>8.4</u>	<u>25.8</u>	90.2	29.2	32.4	247
				II	4.7	<u>3.81</u>	<u>8.5</u>	<u>27.4</u>	90.6	29.1	32.6	241
				III	4.9	<u>3.85</u>	<u>8.7</u>	<u>27.6</u>	↑96.5	29.6	33.6	247
7/6	DDT <u>3.17</u> (II)	DDE ↑39.20(II)	- No specific illness complained	I	5.0	4.18	<u>10.1</u>	<u>30.8</u>	<u>73.5</u>	<u>24.2</u>	32.9	175
				II	5.2	4.20	<u>10.5</u>	<u>30.9</u>	<u>73.7</u>	<u>24.5</u>	33.1	179
				III	5.0	4.19	<u>10.4</u>	<u>31.1</u>	<u>73.7</u>	<u>24.6</u>	33.3	186
10/3	Cyper ↑32.40(I) Mono ↑29.60(II) ↑34.00(III)	Delta ↑40.00(II)	- RTI - Feel sedation usually - Difficulty in breathing - Headache - Backache and joint pain	I	6.3	<u>3.98</u>	<u>11.5</u>	<u>34.5</u>	86.7	28.8	33.3	289
				II	6.3	<u>3.96</u>	<u>11.2</u>	<u>34.3</u>	86.5	28.6	33.1	287
				III	6.3	<u>3.97</u>	<u>11.4</u>	<u>34.4</u>	86.7	28.8	33.3	288
14/1	Cyper <u>2.01</u> (I) ↑6.03(III) DDT ↑7.30(I)	Mono ↑13.90(II) <u>2.52</u> (III)	- Dyspnea - RTI - Cough sputum - General weakness	I	5.7	<u>4.42</u>	<u>12.3</u>	<u>36.0</u>	81.5	27.9	34.2	202
				II	5.7	<u>4.41</u>	<u>12.1</u>	<u>36.1</u>	81.4	27.8	34.1	202
				III	5.7	<u>4.40</u>	<u>12.1</u>	<u>35.8</u>	81.2	27.4	34.1	203

St. No. = Station number; - = High value; Under line = Low value; Rds. = Readings, I = 1 day (1st reading); II = 7 days (2nd reading); III = 30 days (3rd reading); Cyper = Cypermethrin; Delta = Deltamethrin; Dia = Diazinon; Prof = Profenophos; DDT = Dichlorodiphenyltrichloroethane; DDE = chlorodiphenyldichloroethylene; Normal values: TLC = Total leucocyte count [4000-11000 Thsd / μ l]; RBC = Red blood cell count [M = 4.5-5.5 millions μ l⁻¹, F = 4.5-5.0 million μ l⁻¹]; Plt = Platelet count [150-400 Thsd μ l⁻¹]; Hb = Hemoglobin [M = 13.5-16.5 g dl⁻¹, F = 12.0-15.0 g dl⁻¹]; Hct = Hematocrit [M = 39-52, F = 37-47%]; MCV = Mean corpuscular volume [76.0-96.0 fl]; MCH = Mean corpuscular hemoglobin [27-32 pg]; MCHC = Mean corpuscular hemoglobin concentration [30-35 g/dl], ↑ = Higher pesticide residual levels, values above 35 g dl⁻¹

lymphocyte monocyte counts as well as high MCV and MCH. In addition these workers also showed low RBC, Hb and hematocrit limits as these persons were exposed to more than one pesticides such as cypermethrin, deltamethrin, monocrotophos, diazinon, DDT and DDE simultaneously, possibly during the spraying time and therefore these persons suffered with respiratory and liver dysfunction. They also complained the symptoms of burning sensation in urine, itching, sedation, chest pain, palpitation and anemia. Similar findings were also noted by other researchers such as Amer *et al.* (2002), Abu Mourad (2005). In sample 5, Station 9 slightly elevated levels of platelets and lymphocyte counts. This young worker also showed low neutrophilic count as exposed to cypermethrin, diazinon and monocrotophos, respectively. He also complained the history of respiratory and chest symptoms as well as dermatological signs. The same finding was reported by Abu Mourad (2005).

Correlation between blood parameters and pesticides of the exposed human subjects has been reported by various researchers. Only 26 subjects had significant variations in their blood parameters possibly due to the cumulative residual effect. In this case sample 1 from Station 1 and sample 5 from Station 13 had been exposed to pesticides for a long time and therefore their

Hb, MCV, MCH, TLC, monocyte and neutrophil counts were high. Such effect has been reported by Dunstan *et al.* (1996) by the exposure of chlorinated hydrocarbons on various blood parameters. Similarly sample 5 from Station 13 and to some extent sample 4 from Station 12 and sample 2 from Station 4 had also high MCH and MCV values. High lymphocyte count was found in almost all the exposed cases.

Mostly low limits of Hb, Hct, MCV, MCH, RBC and neutrophil were found in such persons. This possibly may be due to toxic effects of pesticides, especially in those persons who did not have long exposure. Fujishero *et al.*, (1994) have reported low platelet count by the exposure of dichloropropanol.

El-Saeed and Hassan (2000) reported the relationship between chronic lymphocytic leukemia and pesticide exposure among Egyptian farm workers. They reported high lymphocytes, WBC and platelet counts. In the present case 90% exposed farm workers also had high lymphocyte values confirming the report of El-Saeed and Hassan (2000). Neutrophils count was also found low in 70% of farm workers which had not been reported so far by other researchers. Yousef *et al.* (2003) correlated the changes in

Table - 1b: Effect of pesticide residues on health and differential leukocyte count in the effected person from different farm stations

St.No. / Sample No.	Related health hazards	Readings	DLC (%)				
			N	E	B	L	M
Male = 19 (17-52 years)							
1/1	- Jaundice (5 yr back)	I	↑82	5	0	12	1
	- Headaches Backaches	II	↑80	6	0	13	1
	- Toxic granulation	III	↑80	6	0	12	2
	- Reactive neutrophilic leukocytosis						
1/5	- Jaundice (6 months back)	I	58	4	0	35	3
	- Backaches	II	57	4	0	↑36	5
	- Joint pain	III	53	4	0	↑42	1
	- Chest pain during work						
	- Nausea						
1/9	- Some time headache	I	51	4	0	↑39	6
	- No specific illness	II	57	3	0	↑38	5
		III	44	↑10	0	↑44	2
1/10	- Nausea(sometimes)	I	44	↑8	↑3	↑35	↑10
	- No specific illness	II	44	↑8	↑3	↑36	↑9
		III	44	↑8	↑2	↑38	6
1/11	- Headache	I	57	5	1	34	3
	- Feel lethargic	II	53	4	1	38	4
	- Backache	III	52	6	1	37	4
1/13	- Symptoms of pneumonia	I	57	5	↑2	29	↑7
	- Dyspnea	II	70	2	0	26	2
	- Feel sedation	III	67	3	0	28	2
	- Numbness of limb						
	- Nausea						
1/16	- No specific illness complained	I	57	2	1	↑37	3
		II	55	4	1	↑37	3
		III	60	2	1	34	3
1/20	- No specific illness complained	I	46	1	Band 4	↑44	4
		II	47	5	3	↑43	2
		III	52	5	3	↑38	2
2/2	- Respiratory discomfort	I	22	2	Band 7	Met 3	6
	- Chest Pain			↑9	↑51		
	- Pneumonatic attack (6 month back)	II	21	3	Band 7	Met 3	6
	- Joint pain	III	22	3	↑10	↑50	
	- Abdominal discomfort				Band 7	Met 3	5
					↑11	↑51	
3/7	- Complained joint pain	I	38	↑12	0	↑46	4
		II	38	↑11	0	↑45	6
		III	42	↑9	0	↑43	6
4/2	- Jaundice (5-6 months back)	I	54	6	0	32	↑8
	- Headache- Leathargic during working	II	53	6	0	32	↑9
		III	44	↑8	0	↑39	↑9

5/1	- No specific illness complained	I	<u>38</u>	↑9	0	↑48	5
		II	<u>34</u>	↑12	0	↑46	↑8
		III	<u>39</u>	↑8	0	↑44	↑9
7/1	- Jaundice (10 months back) - Headache sometimes - No specific illness complained	I	<u>51</u>	5	1	↑39	4
		II	<u>48</u>	↑8	0	↑38	6
		III	<u>41</u>	↑8	0	↑43	↑8
7/2	- Jaundice (5 yrs back) - No specific illness complained	I	<u>44</u>	6	1	↑43	6
		II	<u>41</u>	↑8	1	↑42	↑8
		III	<u>44</u>	6	1	↑43	6
8/1	- Nausea - RTI - Vomiting - Joint pain - Jaundice (1 yr back)	I	<u>61</u>	5	1	31	2
		II	<u>60</u>	5	1	32	2
		III	<u>60</u>	5	1	32	2
9/5	- Complained kidney dysfunction - Burning sensation in urine	I	<u>44</u>	4	↑2	↑47	3
		II	<u>44</u>	4	↑2	↑47	3
		III	<u>44</u>	4	↑2	↑47	3
11/1	- Jaundice 7-8 months back - Vomiting and nausea usually - Dyspnea at working time - Joint pain- Feel discomfort	I	<u>48</u>	5	1	↑43	3
		II	<u>48</u>	6	1	↑42	3
		III	<u>48</u>	5	1	↑43	3
12/4	- Jaundice 6 months back - Backache - Difficulty in breathing - Joint pain frequently	I	<u>45</u>	4	2	↑45	4
		II	<u>46</u>	4	2	↑44	4
		III	<u>49</u>	3	2	↑43	3
13/5	- Jaundice(6 months back) - Dyspenia - Cyanosis - Vomiting - Feel headache feel general weakness at working time	I	<u>51</u>	7	0	↑40	↑8
		II	<u>51</u>	7	0	↑41	↑8
		III	<u>47</u>	7	0	↑40	↑8
Female = 7 (28-60 years)							
1/7	- Not complained any specific illness	I	<u>59</u>	5	1	32	3
		II	<u>61</u>	5	1	32	5
		III	<u>65</u>	5	1	28	1
1/8	- Not specific illness complained	I	<u>60</u>	4	1	32	3
		II	<u>58</u>	3	0	36	3
		III	<u>56</u>	3	0	38	3
3/6	- Jaundice (10 yrs back)	I	<u>28</u>	6	↑3	↑55	↑8
		II	<u>33</u>	↑11	↑2	↑46	↑8
		III	<u>41</u>	6	↑3	↑42	↑8
7/4	- Jaundice (4 months back) - Chest pain (during working) - General weakness	I	<u>47</u>	↑7	1	↑40	5
		II	<u>48</u>	↑8	1	↑37	6
		III	<u>49</u>	↑7	1	↑38	5

7/6	- No specific illness complained	I	57	6	1	32	4
		II	57	6	1	32	4
		III	59	↑7	1	29	4
10/3	- RTI	I	66	↑8	0	<u>24</u>	2
	- Feel sedation usually	II	66	↑8	0	<u>24</u>	2
	- Difficulty in breathing	III	66	↑8	0	<u>24</u>	2
	- Headache						
	- Backache and joint pain						
14/1	- Dyspnea	I	51	6	0	↑39	4
	- RTI	II	51	6	0	↑39	4
	- Cough seputum	III	<u>47</u>	6	0	↑44	3
	- General weakness						

St. No. = Station number; - = High value; Underline = Low value; I = 1 day (1st reading); II = 7 days (2nd reading); III = 30 days (3rd reading); Normal values; N = Neutrophils [50-75%]; E = Eosinophils [2-6%]; B = Basophils [0-1%]; L = Lymphocytes [25-35%]; M = Monocytes [2-6%], ↑ = Higher value

Table - 2: Determination of blood parameters and differential leucocyte counts in the human blood of normal (control) persons

Sample No.	Blood parameters							DLC					
	TLC	RBC	Hb	Hct	MCV	MCH	MCHC	Plt	N	E	B	L	M
Male = 19 (17-52 years)													
1	6.2	5.27	15.6	45.3	86.5	29.7	33.3	242	58	5	0	29	3
2	4.6	5.13	14.8	41.9	78.3	28.5	32.6	227	61	4	0	31	4
3	5.3	4.71	12.2	41.3	80.2	29.7	31.8	178	57	3	0	27	2
4	4.8	5.29	14.9	42.4	85.5	28.6	33.0	212	63	3	1	29	3
5	4.5	4.68	13.7	43.5	87.2	29.3	31.6	186	68	5	0	26	5
6	6.1	4.83	14.1	41.8	85.9	31.3	33.4	197	66	4	0	27	4
7	5.6	4.97	14.3	43.1	84.7	28.4	32.1	188	52	5	0	32	5
8	6.1	5.26	13.7	42.4	79.3	29.1	31.2	204	51	4	0	28	3
9	7.6	5.13	14.8	43.2	91.6	31.1	32.7	187	69	5	0	31	5
10	6.3	4.62	13.5	41.5	80.8	29.4	30.8	221	62	4	0	29	4
11	7.4	5.37	14.6	42.4	81.6	30.3	31.7	186	66	3	1	27	4
12	4.8	5.29	14.3	41.9	79.4	28.9	32.1	204	59	5	1	30	5
13	6.1	5.33	15.1	43.3	89.7	29.3	33.1	228	61	4	0	29	4
14	4.9	4.78	12.7	41.2	78.4	28.7	31.6	212	62	4	0	31	3
15	5.7	4.67	13.2	33.3	81.5	30.3	30.7	189	57	3	0	28	3
16	7.1	5.12	14.3	32.0	85.6	31.4	32.4	177	53	3	0	30	4
17	4.8	5.31	13.7	36.9	87.7	29.4	31.7	209	54	4	0	29	3
Female = 7 (28-60 years)													
18	5.1	5.36	13.3	35.6	91.2	30.8	32.1	288	61	3	0	31	5
19	4.8	4.72	12.9	41.4	79.3	29.7	31.8	211	59	4	0	27	3
20	7.2	5.32	14.1	42.6	93.2	31.6	30.7	241	62	4	0	28	4
21	4.8	4.72	12.9	41.6	89.9	29.8	32.2	210	58	3	0	29	5
22	6.1	4.67	13.1	37.9	79.2	28.7	30.9	193	56	3	1	31	5
23	5.9	5.21	14.7	41.3	78.8	29.2	31.6	213	61	4	0	30	4
24	5.1	4.82	13.9	38.2	81.6	30.7	32.1	246	57	4	0	28	3
25	5.3	4.93	13.3	40.4	83.7	31.4	32.4	199	59	3	0	27	4

Normal values: TLC = Total leucocyte count [4000-11000 Thsd / μl^{-1}], RBC = Red blood cell count [M = 4.5-5.5 million μl^{-1} , F = 4.5-5.0 million μl^{-1}], Plt = Platelet count [150-400 Thsd μl^{-1}], Hb = Hemoglobin [M = 13.5-16.5 g dl^{-1} , F = 12.0-15.0 g dl^{-1}], Hct = Hematocrit [M = 39-52, F = 37-47%], MCV = Mean corpuscular volume [76.0-96.0 fl], MCH = Mean corpuscular hemoglobin [27-32 pg], MCHC = Mean corpuscular hemoglobin concentration [30-35 g dl^{-1}] N = Neutrophils [50-75%], E = Eosinophils [2-6%], B = Basophils [0-1%], L = Lymphocytes [25-35%], M = Monocytes [2-6%]

Table - 3: Determination of different blood parameters by analysis of variance technique (Anova) General Linear Model (GLM)

Source of variation	Degree of freedom	Seq SS	Adj SS	Adj MS	F	p-value
Time levels	3	77	67	34	0.05	0.954
Blood Parameters	8	8584905	8590695	1073837	1514.00	0.0001
Stations	14	36103	36103	2777	3.92	0.0001

hematological indices induced by isoflavones and cypermethrin. They also reported that cypermethrin significantly decreased the Hb, RBC count, PCV but while isoflavones alone did not cause any significant changes in these parameters. Abu-Mourad (2005) evaluated the health impact of insecticides on Palestinian farm workers in the Gaza Strip and also assessed the hematological biomarkers in those persons who used organophosphorus insecticides.

In view of significant changes in the levels of different blood parameters due to hazardous effects of pesticides, many spray workers from 13 horticultural stations were advised not to spray pesticides for at least one year and two of them were asked not to expose themselves to pesticides. This was done to save their health and life. Moreover they were also instructed for the importance of protective measures, regular periodic health examinations, use of phytopesticides instead of conventional pesticides and other IPM techniques which will be beneficial for the sake of human life and environment.

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