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# General and Reproductive Toxicity of 2,4-Dichlorophenoxyacetic acid (2,4-D)

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## Abstract

The use of pesticides adversely affecting human, animal and environmental life occurs as a result of soil, air and water contamination. 2,4-Dichlorophenoxyacetic acid (2,4-D) is a selective herbicide of the phenoxyacetic acid group. It is the most highly used herbicide in the world. The most serious problems are irresponsible use. Due to improper use of the herbicide occur serious of environmental problems nowadays. This review will explain general and reproductive toxicity of herbicide 2,4-D.

**Keywords:** Toxicology; Reproductive; Dichlorophenoxyacetic acid; Herbicide

## Introduction

Research aimed at the health risks caused by environmental pollution in parallel to the increase in the use of pesticides in recent years has attracted a great deal of attention. The use of pesticides adversely affecting human, animal and environmental life occurs as a result of soil, air and water contamination. Pesticides may have direct effects on sperm production via genetic damage to the sperm cells or hormonal imbalances. 2,4-D has demonstrated toxic effects on the thyroid and gonads following exposure, there is concern over potential endocrine-disrupting effects. These chemicals may also be transmitted through the seminal fluid to the woman and the fetus [1].

The pesticide-sourced residue problem is one of the most important problems of Turkey and the world. Pesticides used at excessive doses not only accumulate in the environment, but also within the living organism via the food chain. While global pesticide production is around 3 million tonnes per year, average annual pesticide production in Turkey is 33 thousand tonnes. Annual pesticide consumption in Turkey between the years of 1979-2007 has shown an increase of 270% (Table 1). This table indicates that Turkey is in serious danger with respect to pesticide pollution. At 24%, herbicides take second place among pesticide use in Turkey [2]. Herbicides used against weeds in agricultural fields cause toxicity problems both directly and indirectly. While herbicide residue poses a risk against environmental and public health via direct contamination, it can also increase the incidence of poisoning by indirectly causing a rise in the cyanogenic glycoside amount and via various other risk factors [3]. Also, during the production of 2,4 Dichlorophenoxyacetic acid and

2,4,5-T, dioxins (2,3,7,8-tetrachlorodibenzo-p-dioxin, TCDD, $C_{12}H_4Cl_4O_2$) are produced, of which dioxin compounds pose a high toxicity to environmental and public health [4].

| Groups of pesticides | 1979 | 1987 | 1994 | 1996 | 2002 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|
| Insecticides | 2.288 | 3.303 | 2.065 | 3.027 | 2.251 | 3.406 | 7.304 |
| Acaracides | 203 | 240 | 192 | 223 | 297 | 219 | 315 |
| Oils | 1.595 | 2.147 | 2.147 | 2.871 | 2.428 | 2.144 | 2.447 |
| Fumigants and Nematicides | 316 | 322 | 531 | 1.077 | 1.559 | 2.65 | 3.031 |
| Rodenticides and Molluscicides | 5.6 | 2.1 | 2.5 | 3.3 | 1.8 | 6.7 | 11 |
| Fungicides | 1.537 | 2.612 | 2.201 | 2.951 | 1.964 | 4.432 | 4.945 |
| Herbicides | 2.452 | 3.495 | 3.903 | 3.644 | 3.697 | 5.4 | 4.638 |
| Total | 8.396 | 12.112 | 10.872 | 13.797 | 12.199 | 18.258 | 22.681 |

Table 1: Annual pesticide consumption in Turkey between the years of 1979-2007 (Ton*).
*Not included copper sulphate and sulphur powder.

The herbicide 2,4-D is an agricultural chemical belonging to the phenoxyacetic acid group and widely used to combat broadleaf weeds. Its use in Turkey is widespread. It is the most commonly used herbicide in the world. Its use increased rapidly following World War II. Humans and animals are exposed to it via drinking water, soil, air, the food chain and during production of the herbicide [5].

Since the structure of the herbicide resembles the plant growth hormone indoleacetic acid, it acts as a growth regulator in plants. The herbicide also inhibits plant development by influencing various events such as, enzyme activity occurring in plant metabolism in weeds, nucleic acid synthesis, protein synthesis and cell division [6].

## 2,4-D Herbicide and General Toxicity

While present data related to 2,4-D suggests the herbicide to be safe (LD50 300/1000 mg/kg live weight, for mammals), there are also studies revealing that even low doses cause neuromuscular disorders such as ataxia and paralysis. It has been reported to cause myotonia by affecting the skeletal muscles in humans, rats and cats [7]. In a research related to its toxicity, it was reported to be placed among the highest endocrine destructing chemicals among pesticides used throughout the world [8]. WHO and EPA determined the maximum dose in drinking water as 70 µg/L, while even low doses were found to be significant with respect to health and toxicological effect [9,10]. In earlier studies performed by the authors aimed at its hepatic toxicity, the herbicide was given to rats at doses of 50 and 100 ppm in food and 25 and 50 ppm in water for 30 days, revealing that even low doses may be toxic for the liver due to causing an increase in ALT and AST levels [11]. In studies investigating its toxic doses, it has been reported that subacute toxic hepatitis develops and is characterised by congested liver, distended hepatocytes, fat infiltration, degeneration, local necrosis or atrophy [12].

Renal tissue is the target organ for 2,4-D. In subchronic studies, many researchers have demonstrated it to be the target organ for the structural, physiological and chemical effects of 2,4-D [5,13]. In the authors earlier studies, 2,4-D has been determined to accumulate in the kidney tissue [4].

Epidemiological studies also support the fact that, in line with the mentioned toxicity data, 2,4-D is related to cancerogenicity and that a relationship has been found between non-Hodgkin lymphoma and this herbicide [14].

## 2,4-D Herbicide and Agent Orange

The herbicidal war created by mixing equal amounts of the herbicides 2,4-D and 2,4,5-T, used as a defoliant by American troops during the Vietnam War between the years 1961-1971, was intensely harmful to a large section of the Vietnamese population due to toxic dioxin contamination. Four million Vietnamese suffered serious health problems caused by exposure to dioxin. Scientific research has supported the fact that it is the main factor in the development of congenital abnormalities, severe skin diseases caused by contaminated soil layers and the food chain, and of various cancer types including the spleen, oesophagus and prostate [15].

## 2,4-D Herbicide and Reproductive Toxicology

Senseless and untimely use of 2,4-D causes severe damage in humans and animals consuming agricultural products due to the residue on these products, as well as in the entire ecosystem. Studies carried out in the field of reproductive toxicology indicate that the herbicide caused structural changes in male reproductive organs and led to a decrease in sperm count by affecting spermatogenesis [16]. In studies aimed at the exposure of workers producing the herbicide and farm workers, fertility was seen to decrease while an increase was observed in abnormal sperm count. Similarly, it has been reported that a high level of the herbicide 2,4-D was present in the urine of workers applying the herbicide in Argentina and that there was a decrease in sperm concentration and morphologically normal sperm count [17]. Levels of 2,4-D were measured in the semen samples, this active ingredient can be excreted by this route and thus could be toxic to sperm cells and be transported to the woman exposing her eggs at fertilization and/or the developing embryo/fetus [18]. Testicular atrophy has been reported in rats after chronic exposure to 300 mg/kg per day 2,4-D in the diet [19].

Agent Orange, used during the Vietnam War, has also been reported to be significant with respect to reproductive toxicity. A high proportion of stillbirths and congenital abnormalities have been reported in individuals exposed to the herbicidal war, in which almost the entire Vietnamese population including children suffered extensive harm. Also the neural tube defect case, where the brain tissue had been severely damaged, was reported to have reached a statistically significant level [20].

Another current knowledge is that, in pregnant women working in fields, by way of inhalation the herbicide can pass the placental barrier and cause tooth abnormalities in the infant [21]. In another study of human exposure, female applicators were found to have a significant increase in cervical cancer associated with 2,4-D application [22].

## Conclusion

The first aim must be to limit the widespread use of 2,4-D, which causes extensive damage in the ecosystem. Farmers must be informed regarding random and senseless use. In conclusion, environmental analysis must be performed regularly and the focus placed on an integrated battle.

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