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# Residues of diazinon insecticide in Ab-bandans adjacent of three rivers of Babolroud, Talar and Siahroud

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**ABSTRACT**

*A study have been done for measuring of Diazinon as a Organophosphorus pesticide in nine Ab-bandan (man-made wetland) in Mazandaran province include Kharjisha, Ramenet, Esmaeelkola, Kordkola, Shrag-e-Larim, Anarmarz, Roshandan, Galeshkola and Langoor from Apr 2010 to Mar 2011. A total of 216 samples were taken from nine Ab-bandan of the south Caspian lowland. Samples analyzing revealed that Diazinon toxin is observed frequently in aquatic ecosystems throughout the year especially in summer. All Ab-bandans except Kharajisha have shown similar yearly trend. Kharajisha as an aquatic system is fed by Babolroud River has almost triple Diazinon concentration than others in summer. In other seasons, this toxin decreases gradually so that winter and spring have lower amount of it. Due to the vast expansion of agricultural fields in the study area, various contaminants such as Diazinon are leached by rainfall, irrigation and drainage activities and then are conducted to the adjacent rivers and Ab-bandans. Thus, development of irrigation and drainage efficiency and some environmental observations under the small land holding condition could be diminish the negative impacts and consequently maintain the ecosystem balance in this region.*

**Key words:** Diazinon, Babolroud, Talar, Siahroud, Ab-bandan

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## INTRODUCTION

One of the most important types of wetland in the south Caspian lowlands is the “Ab-bandan” a small, man-made reservoir or flooded rice paddy with a luxuriant growth of underwater vegetation. These shallow wetlands, varying in size from 3 ha to 1,000 ha and mean depth 1m, provide excellent feeding and roosting areas for large numbers of migratory waterfowl. Most were originally built as temporary water storage areas to provide water for irrigation during the dry summer months. However, many also serve as private reserves for duck-trapping during the winter months; some have been built specifically for this purpose, and as such are jealously guarded. Although these Ab-bandans represent only a small proportion of the total wetland habitat in the south Caspian, they comprise a very important component of the habitat available for waterfowl because they embrace some of the richest feeding habitats in the region, and provide undisturbed areas where waterfowl can rest during the day. The construction of large dams on the main rivers at some time in the future would render many of the Ab-bandans obsolete for irrigation purposes, and could lead to their conversion to agricultural land, very much to the detriment of wintering waterfowl. In recognition of this potential threat, the maintenance and preservation of Ab-bandans has become an important part of the Department of the Environment's program of wetland conservation in the south Caspian region.
Most areas of plain regions in Mazandaran province are planted with rice, and different pesticides and fertilizers are used at high densities to increase the yield of production. Diazinon is the main insecticide that being used to control stem boring caterpillar of rice (*Chilo supressalis*), lice, blowflies, ked, ticks in sheep, cattle, goats and dogs etc. are for control of aphids, caterpillars, moths, butterflies, various worms, locusts, grasshoppers and scale in pastures, orchards, vegetables and field crops. It comprises about 23% of all used pesticides in Mazandaran and Golestan provinces (Abbasian et al., 2012). The main problem is the high groundwater table in the region, and consumption of this water by local people and anthropogenic side effects of water pollutants. Water sampling from 10 shallow

wells located in seven villages was carried out during summer and autumn of 2006. The results of study showed that the residue of Diazinon in groundwater of Mahmoud Abad area was 0.002 to 0.572µg/l**.** In some samples the concentration of Diazinon residues in water samples was higher than WHO maximum residue limits (0. µg/l) ( Khazaei et al., 2010).

## MATERIALS AND METHODS

### Study Area

Study area extends from Babolroud to Siahroud (Fig. 1). Many Ab-bandans created in this area such as Kharjisha, Ramenet, Esmaeelkola, Kordkola, Shrag-e-Larim, Anarmarz, Roshandan, Galeshkola and Langoor were selected measuring of diazinon toxin. All mentioned Ab-bandans feed mainly by babolroud, Talar and Siahroud rivers and somewhat through rainfall, drainage and underground water. Total Ab-bandans estimated 506 in Mazandarn province having 14811 ha area. They have distributed through 635 villages so benefit about 50000 families. Silver carp (*Hypophthalmichthys molitrix*) and grass carp (*Ctenopharyngodon idella*) are the most common culture fish in Ab-bandans make one of local livelihood ways partially.

Their exact coordinate and schematic location is being shown in (table 1) and (fig. 1) respectively.

**Table 1: Geographic characteristic of Ab-bandans**

| Ab-bandan name | Coordinate | | |
|---|---|---|---|
| | Zone | X | Y |
| Kharjisha | 39S | 654773 | 4050979 |
| Shrag-e-Larim | 39S | 672472 | 4066609 |
| Kordkola | 39S | 670249 | 4064929 |
| Anarmarz | 39S | 664541 | 4063428 |
| Roshandan | 39S | 660108 | 4058738 |
| Galeshkola | 39S | 659120 | 4055725 |
| Esmaeelkola | 39S | 662249 | 4056199 |
| Langoor | 39S | 656249 | 4053533 |
| Ramenet | 39S | 655856 | 4048484 |

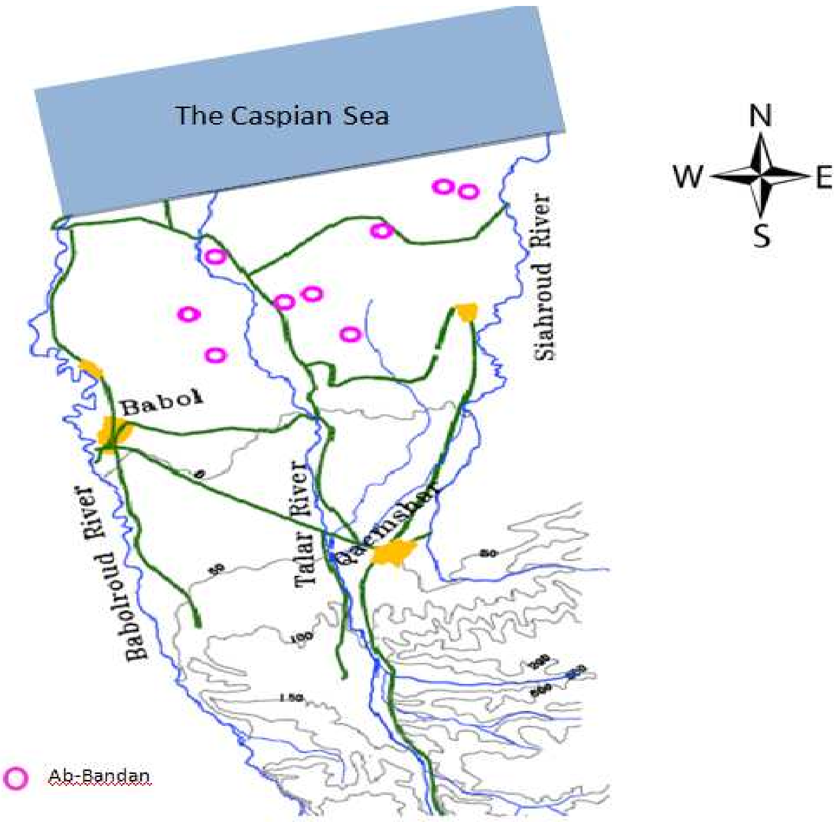


**Figure. 1: Schematic review of the study area**

**Table 2: Different land use pattern in study area**

| | Land use | Area (ha) | Area proportion |
|---|---|---|---|
| Farmland | Paddy | 43120 | 46.8 |
| | Orchards | 8980 | 9.8 |
| | Non-paddy | 9560 | 10.4 |
| Non-farm | Residual | 19400 | 21.1 |
| | Forest | 1120 | 1.2 |
| | Ab-bandan | 3930 | 4.3 |
| | River | 690 | 0.7 |
| | Barren | 1085 | 1.2 |
| | Others | 4165 | 4.5 |

Farmlands contain 67% of total area in which rice lands are 70%, orchard more than 14.5% and 15.5% comprise other products. Non-farm contain 33% of total area dedicated 63.8% to residual, 12.9% to Ab-bandan, 3.7% to forest, 3.6% barren, 16% to others (table 2).

Study Method
Nine Ab-bandan including Kharjisha, Ramenet, Esmaeelkola, Kordkola, Shrag-e-Larim, Anarmarz, Roshandan, Galeshkola and Langoor were selected among many Ab-bandan for measuring Diazinon concentration as one of organophosphorus toxin in Mazandaran. All Ab-bandans were chosen near rivers in order to establish an equal condition in sampling. Sampling was being every mid-month and sampled from middle across and depth of the Ab-bandan. Two samples were always gotten in each station to avoiding the shortage of sample volume, and were sent to laboratory for analyzing immediately measuring by specific method and instrument. Samples analyzed by means of nitrogen-phosphorus detector (NPD) and gas chromatography. Identification and measurement was done by standard stop time toxicants and calibration curve graph.

## RESULTS AND DISCUSSION

Due to the extensive application of insecticides in the rice paddies of the Caspian coasts of Iran, this investigation was carried out on the rice fields in order to obtain the necessary data and information on the concentration of Diazinon. (Fig. 2) shows Diazinon concentration is significantly more in summer than other seasons of all nine Ab-bandans. They have similar trend of Diazinon concentration so that increase in spring gradually and reaches peak in aquatic ecosystems during summer. Similar studies (Khoobdel, 2008) have shown significant difference of Diazinon and Azinphos-methyl concentration during summer and other seasons in Qarahso and Gorganroud rivers ($P<0.05$).

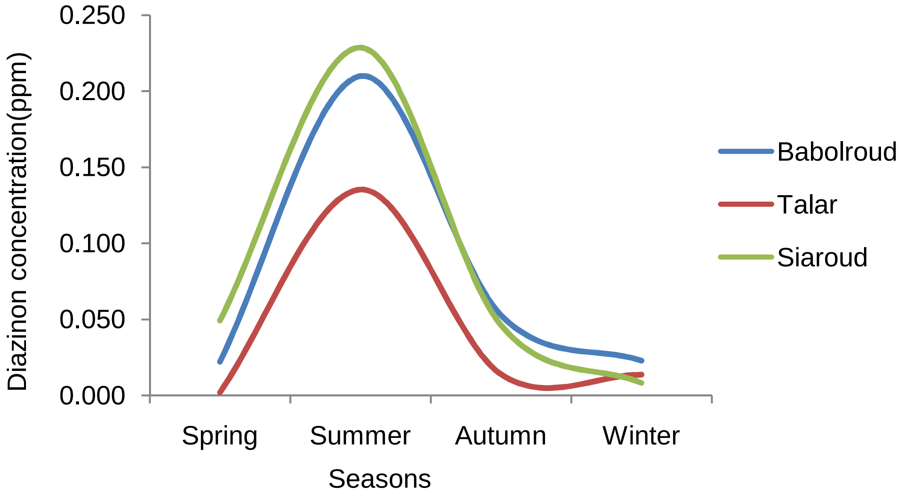


**Figure. 2: Diazinon seasonal fiuctuation in different rivers**

The results showed that the quantity of Diazinon insecticide in water samples was 0.005 to 0.6µg/1.Kharajisha, however, shows more increasing trend as much as 3-10 times in comparison with others during summer. On the other hand, rivers which feed these Ab-bandans have also more concentration in summer similarly (Fig. 3); in fact there is direct correlation between river and Ab-bandan's Diazinon concentration. Diazinon use decrease when cultivation season ends and its concentration decrease concurrently in aquatic ecosystems. As a matter of fact, rivers are not the only source of Ab-bandan's Diazinon so far agriculture drainage of adjacent lands also entered into them.

For example, Siahroud has more concentration in summer so it is expected the most amount of Diazinon in adjacent Ab-bandans, whereas Kharajisha in babolroud adjacent reveals more than others. When summer ends, Diazinon use reduces gradually and its amount similarly falls in autumn. Winter and spring having lower use in tune with crop pattern so its amount always is lower than both rivers and Ab-bandans.

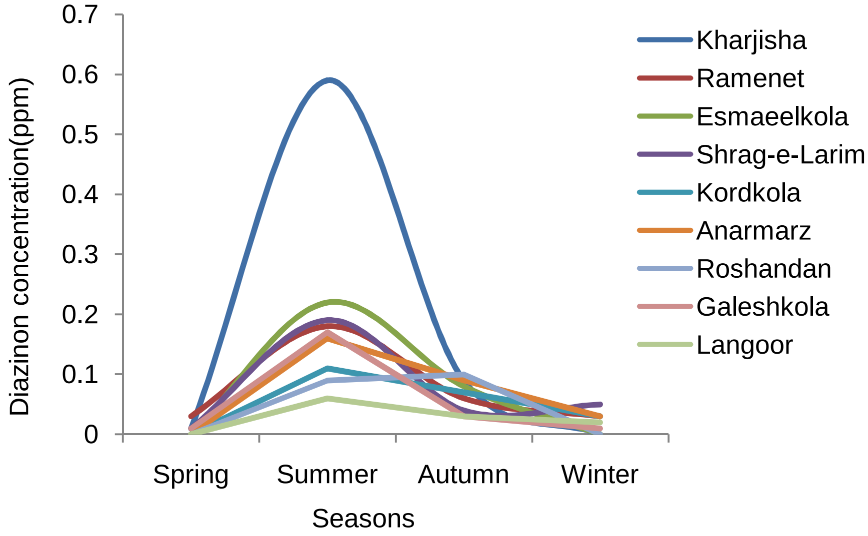


**Figure. 3: Diazinon seasonal fluctuation in different Ab-dandans**

In most rice paddies in Mazandaran Province, Diazinon is applied to control stem boring caterpillar of rice (*Chilo suppressalis*). The existence of agricultural activities has a main role on surface water resources pollution in Mazandaran province. Agricultural drainage water contains dissolved salts, pesticide residues and chemical fertilizers especially nitrate. The aim of this study was the possibility of existence of Diazinon, a pesticide with the highest use in region. Results indicate that the insecticide was used frequently to control stem boring caterpillar of rice. The residuals of this toxic chemical were observed in the majority of stations from the day after the spraying until one to two months later. In Tajan river, the simulated results showed Diazinon insecticide about four months (Ahmadi, 2001). Two weeks after spraying, Diazinon reveals more than standard amount in common carp *(Cyprinus carpio)* and Chub (*Leuciscus cephalus*) in Qezel ozan of zanjan (Hamidi et al., 2012). A 2005 study in Bushehr revealed, Diazinon residue is more than admissible amount in rivers of Mond, Shahpour and Dalaky (Shayeghi et al., 2007).

The fate of diazinon in river depends on water outflow and degradation. The water flow has a main role on outflow of diazinon in Tajan river.

Physical and chemical properties of the studied Diazinon such as fumigation characteristic as well as the ecological conditions and soil type influence the reduction and eventual removal of the insecticides during the cultivation and harvest periods (Arjmandi, 2010). Retention time is varies strongly in water, soil and biota. For example, Ezemonye et al., (2008) showed decreasing order of occurrence of the Diazinon was as follow; fish > sediment > water. The concentrations observed in fish (*Chrysichthys furcatus*) were higher than the levels observed in sediment and water suggesting bioaccumulation of the pesticide by the fish. Spatial variations occurred with downstream stations having statistically higher concentrations in all matrices at $P< 0.05$. Seasonal variations occurred with higher concentrations in dry season for water and sediment only, while the fish species had higher concentrations in the wet season.

Limited data indicated that the yellowtail (*Seriola quinqueradiata*), a marine teleost, was 84X more sensitive to diazinon than were 4 species of freshwater fishes, as judged by LC-50(48 h) values, and by its inability to biotransform diazinon to nontoxic metabolites within one hour (Fujii and Asaka, 1982). Diazinon has not been detected in marine waters, but the potential exists for contamination of estuarine areas from agricultural and urban runoff (Ronald Eisler, 1986). Simulation of retention time Diazinon in river showed that highest concentration of Diazinon effected on fauna. The bioaccumulation of Diazinon was studied in bluegill sunfish (*Lepomis macrochirus*) according to US EPA data requirements (Fackler, 1988). The steady state bioaccumulation factors were determined to be 470X, 540X and 500X for the edible, non-edible and whole fish tissues respectively. Elimination of Diazinon from these tissues was rapid, with half-life of between 1 and 3 days, indicative of rapid depuration.

A study of Giddings (2000) showed Diazinon, is used in the Sacramento – San Joaquin River Basin as a dormant spray on almonds and other tree crops, as well as for other agricultural and urban applications. Diazinon and other pesticides have been detected in the Sacramento and San Joaquin Rivers and their tributaries. The assessment addressed the possibility that reductions in invertebrate populations could lead to impacts on species of fish that feed on those invertebrates. The risk assessment concluded that fish in these rivers are not at risk from the direct effects of Diazinon in the water. Invertebrates are at greater risk, especially in agriculturally dominated streams and drainage channels during January and February.

Incidence of reproductive condition was found to be reduced 20 to 80% and 33 to 100% in Diazinon-exposed males and females, respectively. Reproductive productivity, including percentage of pregnant females and of females giving birth, was significantly reduced in Diazinon-exposed animals. Percentage of pregnant females ranged from 13.6 to 43.5% in Diazinon-exposed animals compared to 40 to 80% for control animals, and percentage of females giving birth ranged from 0 to 17% in Diazinon-exposed animals compared to 22 to 50% for control animals. Generally, the effects found in this study suggest that Diazinon was relatively persistent in the sprayed enclosures and that oral routes of exposure (consumption of dead and dying arthropods, grooming) may have been important. Ecological relationships and reproduction in both herbivorous and omnivorous mammals were negatively impacted by Diazinon exposure. Overall, ecological relationships in the enclosed prairie grassland ecosystem were disrupted by Diazinon, probably through a combination of sub-lethal effects, particularly reproductive effects, impacting individuals and their populations. This suggests that negative impacts on populations and community structure and function may persist longer than Diazinon persists in the environment (Sheffield, 2001).

U.S. EPA is terminating all indoor residential and indoor nonresidential uses of Diazinon. U.S. EPA and the registrants also have agreed to phase out and cancel outdoor residential lawn and garden uses over the next few years. Together, these actions will end about 75% of the current use of Diazinon. U.S. EPA and the registrants have further agreed to remove about one-third of the agricultural crop uses of Diazinon. This action will also help reduce risks to workers, birds and other wildlife, drinking water resources, and the environment (U.S. EPA Cancels Diazinon Uses, 2001).

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