Review Article

Impacts of Various Insecticide Forms on Avian Health and Mortality:A Comprehensive Review

Abstract

Since the time of its synthesis and application, insecticides have prevented millions of deaths in humans, animals and avian lives. They have significantly contributed to the revolution in agriculture and human health by reducing agricultural pests and vector-borne illnesses. The chance of birds being exposed to insecticides is increased by a number of factors, including farming methods, insect and crop kinds, pesticide form, food, and habitat preferences.Granularinsecticides,oftenusedinagriculture,arehighlyconcentratedandattractiveto songbirds,shorebirds,andwaterfowl.Liquidsprays,particularlythoseusedforlocustcontrol,canaff ectbirdspeciesbeyondagriculturalareasdue to wide-range applications. Treated seeds can poison birds depending on various factorsliketoxicityandseedavailability.Despitetheknowndangers,manypesticide-relatedbirddeathsgounreported, highlighting the need for comprehensive studies to understand and mitigate theseeffects.Insecticides have a variety of sublethal effects on birds, such as deformed embryos, smaller broods, less vigilant parenting, weakened territorial defence, anorexia and weight loss, weakened immune response, lethargic behaviour, increased susceptibility to predators, disruption of the endocrine system, interference with thermoregulation, and inability to orient in the correct direction for migration. Therefore, exposure to pesticides lowers the likelihood of survival and successful reproduction, which eventually interferes with the growth of a robust bird population.

Keywords: Agrochemicals,Birdsandagriculture,Biodiversity,Insecticides,Pesticideexposure, chronic effect, Environmental pollution

Introduction:

Theeffectsofthepesticidesareincreasingnowadaysduetoitstoxicityandmoreovertheycauseim pactsonvarioustrophiclevelsanditmainlyaffectsthebirdsandbioaccumulatesandcausesseriouseff ects.Inrecentyearsthemanufacturingandconsumptionofagrochemicals(pesticides,insecticides,h erbicides)worldwidehavebeenincreasingdramatically. Most pesticides damage non-target plants and animals in addition to the insectthey are intended to kill. Most of the agrochemicals has high persistence ability which resiststhedegradationmainlypersistinthesoilandgetsleachedtogroundwaterandcontaminatethe soil and aquatic environment (1).

Due to the direct and secondary effects of pesticides, habitat change, intensified land use,andotherreasons,themajorityofbirdspeciesthatinhabitagriculturallandscapesareexperiencingadecline.Theuseofpesticides,whichistypicallyconnectedtocontemporary agriculture, can endanger the survival of ecosystems by reducing biodiversity (flora andfauna) and contaminating natural resources, including groundwater, which affects both theenvironment and human health. According to a survey, herbicides kill between 0.25 and 8.9birdsperhectareofagriculturallandannually.Duetothesevereimpactofpesticidesapproximately 67 million birds die each year.

The negative impact of the pesticides had been increasing mainly after the introduction ofchemical pesticides which causes increase in the expenditure in agriculture and moreoverincreaseinthepesticidedriftbymeansofairandwater.Thepesticidesnotonlybeingtoxictothelivingorganismsandcontinuoussprayingofpesticidesleadstoincreaseinthepesticide resistance were developed in the microorganisms.The majority of pesticides are synthetic substances meant to prevent, eradicate, repel,or lessen any type of insect. The Insecticides contribute a major part of agrochemicals used tokillinsectsHerbicidesareusedtokillweeds.Thefungicidesaremainlyusedtocontrolfungal plant diseases. The Rodenticides are also the synthetic compounds used for the killingof rats, mice and other rodents.

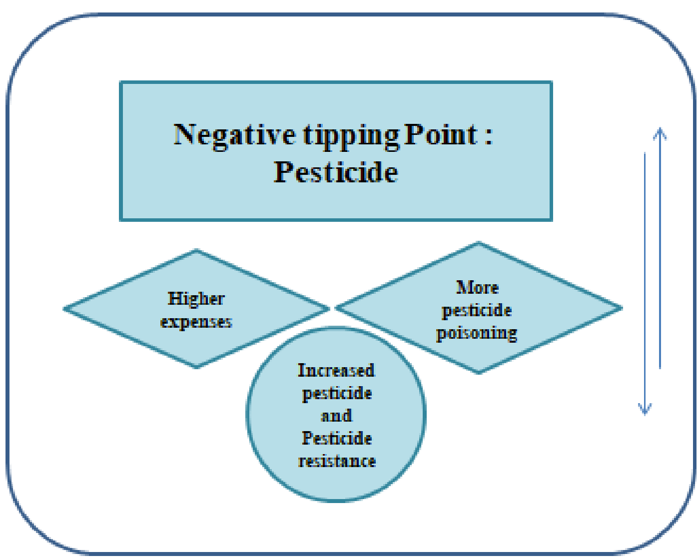

Fig. 1. Impact of pesticides

1.Status of usage:

A closer examination of pesticide use reveals that we are spraying crops more frequently and using more pesticides than ever before. The FAOSTAT database shows that the amount of pesticides used worldwide (measured in tonnes of active ingredient) grew by 58% between 1996 and 2023. Pesticides operate by harming the animals they are intended to kill. But not every species responds to pesticides in the same manner. They have an effect on non-target species as well. The most often used pesticides are pyrethroid, carbamate, and organophosphate. Presently, five million tonnes are used annually worldwide, with herbicides accounting for the majority (44%), followed by insecticides (27%), fungicides (22%), and other types including nematicides and rodenticides.

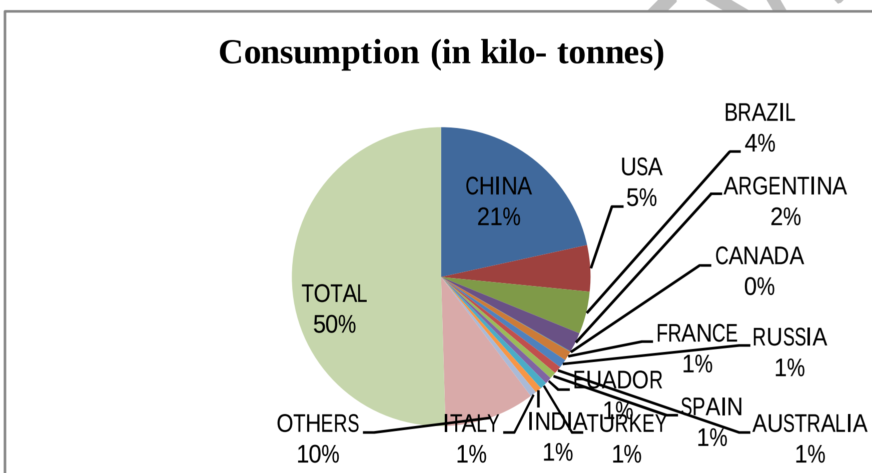

Fig. 2. Consumption pattern over the Globe (FAO, 2018)

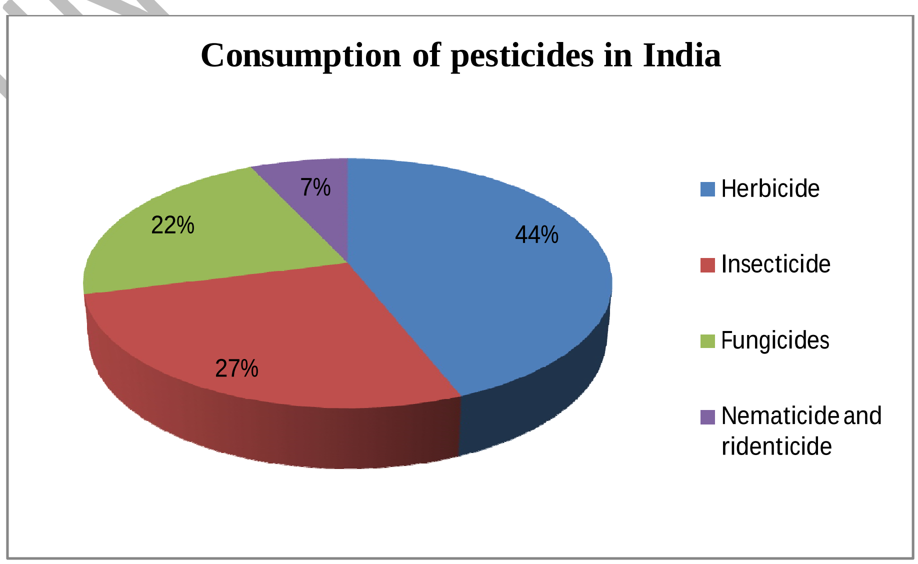

Fig 3. Consumption pattern in India (FAO, 2018)

- In the consumption of agrochemicals in world scenario the insecticides usage wasabout 44% while the herbicides and fungicides usage are 30% and 21% respectivelywhile other agrochemicals includes 5% of the use. In Indian scenario the utilization ofthe agrochemicals such as insecticides, herbicides and fungicides are 56%, while world share include for about 1% (Fig.3).

3. **Role of birds and agriculture**:

VarioussourcesreporttheHousecrow(*Corvussplendens*)feedingondeadsewerrats, offal, carrion, kitchen leftovers and garbage, locusts, termites, fruit, grain, and eggs, orfledglingbirds. FlemingSr.andFlemingJr.madeasubstantialcontributiontoNepalese ornithology. Thesecond-largestcityinthenation,Biratnagar(LatitudeN26^{o}29',Longitude E 87^{o} 16', altitude 72m), is the subject of the study effort covered in this paper. Itcovers an area of 760 square km.

The core region of Biratnagar is inhabited by agricultural land and human settlementson the eastern and western flanks. In Biratnagar's agricultural areas, which are located in thenortheast (Kanchanbari), northwest (Air Port), southeast (Jatuwa), and southwest (Bakhary),birds were frequently observed. In order to investigate feeding habit and its function in pest control, binoculars,cameras, and field manuals were utilized (2).

Crow pheasants (*Centropus sinensis*) have been seen to consume huge amounts of thesofter sections of garden snails (*Achatina fulica*) in the early morning and afternoon. Paddy-destructive crabs were observed being consumed by house crows (*Corvus splendens*). Thefollowinganimalsfedongrasshoppers:Indiantreepie(*Dendrocittavegabunda*),Crowpheasant (*Centropussinensis*),Smallgreenbeeeater(*Meropsorientalis*),Blue-tailedbeeeater (*Meropsphilippinus*), Common myna (*Acridotheristristris*), Bank myna (*Acridotherisginginianus*), House crow (*Corvus splendens*), and Red-vented bulbul (*Pycnonotuscafer*).TheBlackDrone(*Dicrurusadsimilis*),theJungleBabbler(*Turdoidesstriatus*),andtheMagpieRobin(*Copsychussaularis*)werethemaincontrollersofnumerouskindsofmoths and butterflies. The Indian treepie (*Dendrocittavagabunda*) consumed weevils. Aphidmanagement by the large-pied wagtail (*Motacillamaderaspatensis*) was discovered. The threemostdamagingpests,housecrows(*Corvussplendens*),junglecrows(Corvusmacrorhynchos), andowls,consumedratsandmice.Birdfeedingbehaviourisinfluencedbya variety of environmental factors, including habitat, location, time of year, water quality,competition (both intra- and interspecific) and food scarcity (3).

Caterpillars, large insects, lizards, small mice, and bird eggs and nestlings are amongthe foods that the Crow pheasant consumes. The eating habits ofhousecrowsandcrowpheasantswereseentohavealteredasaresultofthesevereenvironmental changes and food scarcity (4). The investigation also disclosed the method bywhich Garden snails are consumed by Crow pheasants. Additionally, the outcome supportedthe diets and feeding patterns of other birds such as the Cattle Egret, Small Green Bee Eater,Blue-tailedBeeEater,CommonMyna,BankMyna,IndianTreePie,Red-ventedbulbul,Piedmyna, Magpie robin, Black drongo, Jungle babbler, Pied crested cuckoo, Gray-headed myna,King fisher, Flycatcher, Large pied wagtail, Owl, and Jungle Crow previously noted byprevious researchers (5).A wider range of activities, such as deforestation, erosion, channelling, flooding,draining, and other processes, as well as the eradication or spread of particular plant andanimal species, are some of the ways that agriculture alters natural ecosystems (6). Agriculture has two key effects on biodiversity. The first method involves clearingpristinehabitatsfornewplantings,whichcomeswithchallengesincludingpollution,disturbance,andhabitatfragmentationforthesurvivinghabitats.Theintensificationofcurrent agricultural systems with the goal of raising crop yields per unit area is the secondfactorcontributingtothereductioninbiodiversity.Duringthepast30years,thishasincreased overall commodity productivity more than new land planting (7).

The behaviour, distribution, seasonal phenology, and demographic patterns of birdsstrongly correspond to the temporal and spatial scales of changes in agriculture. Features seenin the patchwork of agricultural ecosystems are reflected in foraging behaviour, nest-siteselection,andbreedingperformance.Importantlifeeventslikematingormigrationareinfluenced by the annual farming calendar's pattern of events. The differences among theirgroupsorpopulationsareareflectionofregional,national,orlocaldifferencesinlanduseor management. Their demographic drift from year to year means that their population patternsare in line with the progression of agricultural transformation (8).

These data are particularly important in showing the strong relationship betweenagricultural practices and ecological trends, especially when combined with equally valuablelong-term land use monitoring. Changing farming practices orconvertinglandcanhaveawiderangeofpotentialecologicalrepercussions.Somearedirectly caused by modifications in the structure or composition of the vegetation and therelatedfaunalgroups.Somearemoredelicatelymediated,suchasbychangesincropphenology. Furthermore, a vast range of indirect effects emerge, such as altered predator-preydynamicsorthechemicaleffectsofagrochemicalsonspeciescomposition.Otherecosystems, such as those downstream or in nearby bordering areas, are also impacted (9).

Increases in agricultural intensity have been connected to sharp drops in farmlandbird populations in Europe, North America, Africa, and Asia (10). Birdsare frequently employed as indicators of agricultural environments. Ten specialist specieswere identified by (11) as being extremely characteristic and heavilydependent on the habitat types in which they occur, occurring virtually exclusively in thosesites and infrequently in other habitat types. The ecological responsibilities of birds aresometimes lost along with unique ecosystems, like marshes or forests.

However, in many instances, reductions in bird populations happen independently ofhabitat loss due to causes such as exploitation, invasive species, diseases, fragmentation, andothers that remove birds and their benefits from ecosystems. Actually, factors other thanhabitat loss pose a threat to half of the threatened species. This is especially true for groupsthat are much more vulnerable than average, such as scavengers (100%), piscivores (80%),herbivores (78%), omnivores (76%), granivores (56%), frugivores (53%), and birds weighing100 g (73%). 6-14% of all historical bird species are predicted to be extinct by 2100, whereas7-25%arepredictedtobefunctionallyextinctand13-52%tobefunctionallydeficient(12).

4.Mode of poisoning:

First generation insecticides:

When it comes to birds, the method of action usually manifests itself primarily inreproductive effects such eggshell thinning or acute mortality. Common examples of first-generation pesticides include dieldrin, aldrin, and DDT, or organ chlorines (13).

Second generation insecticides:

Cholinesterase inhibition is the mode of action, causing neurological consequencesthat can be fatal or sub-lethal. Carbamates and organophosphates are two instances of second-generation insecticides. Barn owls (*Tyto alba*), American kestrels (*Falco sparverius*), Red-tailed hawks (*Buteo jamaicensis*), Great horned owls (*Bubo virginianus*), and Bald eagles(*Haliaeetus leucocephalus*) are the primary avian fauna affected by cholineesterse inhibition (13).

The pesticide cycle is mainly the biotransformation of the pesticides which tends tobiomagnifyandbioaccumulateinbiologicalsystemsandcausesseriouseffects.Afterapplication of pesticides it gets absorbed by the crop and the remains are leached by the rainwaterorirrigation.Somefractionofpesticidesisdegradedbybacterialoxidationorchemical hydrolysis while some parts are leached from the soil through surface runoff andleaching and enters into the water bodies. The other route of pesticide transformation was thepesticides gets vaporised to atmosphere and they are degraded by UV light and then comesagain to the soil and water bodies as rain and easily enter in to any biological system.

Fig 4. Pesticide cycle

Types of pesticides that raise the chance of exposure

The different forms of insecticide which pose threat to birds are as follows;Granular forms:

Granular pesticides are highly concentrated insecticides that are frequently used in agricultureto protect crops from certain pests and are frequently linked to songbird mortality. Eg: Particularly attractive to songbirds, shorebirds and waterfowl (14). Granular pesticides are highly concentrated insecticides that are frequently used in agricultureto protect crops from certain pests and are frequently linked to songbird mortality. Eg: Particularly attractive to songbirds, shorebirds and waterfowl (14).

Thetoxicityandrateofapplicationofagrochemicalsinliquidformaffectthemortality rate of birds. Several bird species experienced sub-lethal impacts from the liquidsprays. Due to their broad range of application, pesticides used for controlling locusts inagricultural regions via aerial spraying may have an impact on species other than those livingin agricultural areas (14).

Treated Seeds

According to studies, certain seed treatments can occasionally poison birds in to the seed, howdensely the exposed seed is packed, the availability of alternate feeds, and the birds' capacityto avoid treated material on purpose. The percentage of birds who developed morality as aresult of exposure to treated seed was probably between 0 and 5 percent (15)

5.Mode of exposure:

The three main ways that avifauna are exposed to agrochemicals are by ingestion,inhalation,andskinabsorption.pesticidesconsumedviaeatingpollutedwater,sprayedinsects and vegetation, or pesticide-soaked granules or seeds. By consuming smaller creaturesthat have previously been exposed to pesticides, birds consume them. Dust that has beentreated or chemical sprays can both cause inhalation. Bathing in pesticide-contaminated watercan cause skin absorption, as can stand in treated soil or vegetation and absorbing via thefeet. Numerous bird species consume enough seeds to be potentially dangerous (16).

Because of the natural food limitations in the autumn and winter, own seeds play a major role in the diets of many rural birds. Birds may consume these seeds and experience hazardous effects because they are frequently treated with insecticides. Information about wild bird exposure risk and the variables influencing it should be integrated with data on treated seed toxicity for the purpose of risk assessment. We examined the contents of the birds' stomachs to determine how red-legged partridges in a central Spanish agricultural area were exposed to seeds treated with pesticides. We quantified the partridges' diet's contribution from sowed seeds and examined its relationship to pesticide exposure. Additionally, we assessed how the composition of the landscape affected partridges' consumption of pesticides and sowed seeds. Partridges ingested half (50.7%) of the fresh biomass during peak sowing period, with winter grain seeds accounting for 42.3% of the biomass devoured. Thirty-three percent of the birds had residues from one pesticide and seven fungicides (active substances). Consumption of cereal-sown seeds has been associated with the presence of pesticides in the digestive tract (17).

Impact of Pesticide exposure on bird

Pesticide exposure severely impacts birds' habitats, mating rituals, territorial defense,and overall health. It causes labored breathing, convulsions, and feather fluffing, increasingrisks of predation, accidents, and food scarcity. Reproductive abilities are reduced, withfailures in mating, territory defense, and nurturing young. Documented pesticide-related birddeaths are few due to limited scientists, funding, and diagnostic challenges. Many deaths gounnoticedasbirdsmayhide,decay,orbescavenged.Sickbirdsevadecapture,complicatin g

analysis.Singingbirdcounts,oftenusedtoestimatepopulations,maynot accuratelyreflectsublethal effects, necessitating more detailed research to document nonlethal impacts (18).

The ecology greatly depends on wild birds. Pollution of the environment can be detected by a decline in the bird population. When pesticides like DDT are used repeatedly in the soil, earthworms absorb them and then birds eat them. This can lead to a significant decline in the number of birds in the area. Birds like the bald eagle and sparrow drastically decline when organochlorine insecticides are used over extended periods of time. A deposit of contaminants in the body revealed the amount of organochlorines in seabird eggs, making them a good indicator of environmental contamination (19).

Reproduction:

- The inability to locate a mate, carry out mating rituals, protect territory, and alterpatternsofattentiontotheiryoungallcontributetoareductioninreproductiveca pacities.Experiments done on red-legged partridges fed with imidacloprid andthiram treated seeds showed adverse reproductive effects at recommended doses aftera 10 day exposure. (20).
- The highest concentrations of PCBs, HCHs, and DDTs were found in the yolk of house crowsfollowed by blue rock pigeons, turkey, sparrows, red jungle fowl, spotted doves, collard doves, and white wag-tails. In the yolk of a house crow, PCB and HCH concentrations were 1700 and 67,000 ng/g fat weight, respectively. The greatest DDT amounts were recorded by Sparrow (mean: 7900 ng/g fat weight, range: 6900-8700). The findings show that the accumulation of OCs in eggs was lower in granivorous or passerine birds than in omnivorous species such as house crows and sparrows. Even the OC concentrations in omnivorous birds' eggs were lower than those found in fish-eating or raptorial birds' eggs.The detrimental effects on reproductive function are the most well-documented among toxicity-related research works because of past records of eggshell thickness-induced reproductive failure susceptibility (21).
- In England showed delayed chick development and impaired blood cholinesteraseactivity in tree sparrows in intensively sprayed (organophosphates) area. By ingesting food that had high pesticide residues, predators are also

indirectlyimpactedbypesticides.Forinstance,DDT.fliesthatresidejustbeneathcattle'sskin.Ithas been demonstrated that feeding cow dung to calves can poison the magpies, whichconsume cattle hair as part of their diet. Frogs cultivated in the pesticide-containing water. There could be comparable issues with other organophosphates(22).

- Muscle samples from 25 dead prey birds from the families Strigidae, Falconidae, and Accipitridae were used to test highly effective chromatographic techniques with tandem mass spectrometry for the detection and quantitation of 108 pesticides and metabolites, some of which are thought to be persistent organic pollutants. High quantities of pesticides that are forbidden for usage were found in the muscle samples that were examined (23).

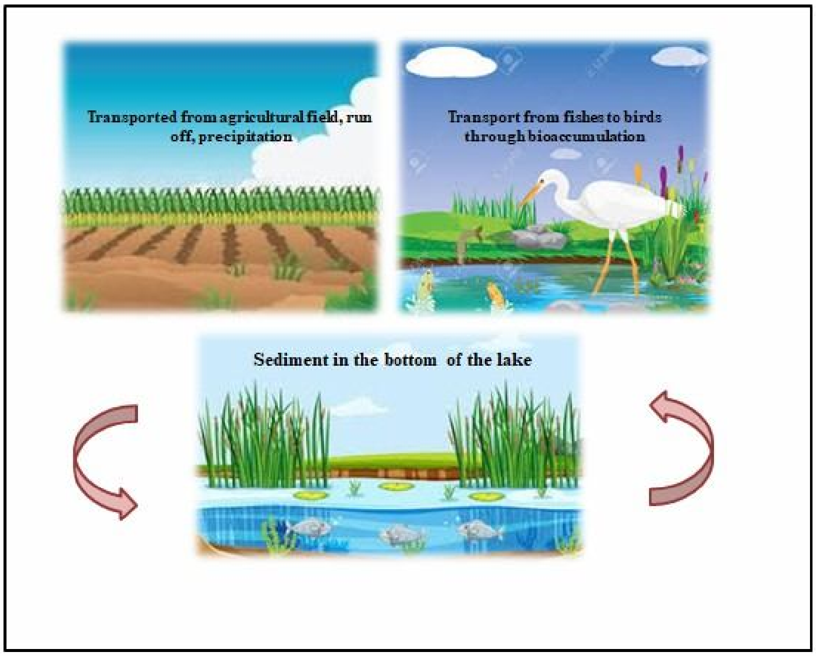

Fig 5. Organochlorines in the food chain

Organo chlorines compounds used as agrochemicals which gets leached and enters inthewaterbodiesandgetscontaminatedinthewateratlowerlevelswhichtherebybiotransform to the phytoplankton-zooplankton-small fishes-Large fishes-predatory birds andthey bioaccumulate at all the trophic levels of the food chain which leads to increase in theconcentration of the contaminants called as biomagnification. In each sucessive trophic levelthe concentration of the OC compounds increases and causes

Organo chlorines:

The cessation of DDT's registered usage did not eliminate the organochlorine threat tobirds. While the use of some organochlorine pesticides, such the miticide dicofol, which alsothins bird eggshells, is still permitted in the US, the use of others, like chlordane, was bannedor restricted far later than DDT. Furthermore, a lot of other nations continue to use DDT andits related substances. Birds that migrate abroad may return to the United States with residuesstoredintheirtissues.Forinstance,theVirginiaWildlifeCenter'sexaminationofgre athorned owls for the presence of organochlorine residues revealed high concentrations of theDDT metabolite DDE and lower concentrations of methoxychlor8 (an further organochlorineinsecticide that is still authorised for use in the United States) and dicofol (25).

Organo phosphorus:

Organophosphorus (OP) and carbamate compounds were originally shown to haveinsecticidaleffectsinthe1930s,andinthe1940s,thesecompoundsweredevelopedforus easpesticides.SincetheUnitedStatesoutlawedtheuseofenvironmentallyharmfulorganoch lorinepesticideslikedieldrinandDDTinthe1970s,theirusehasincreased.Pesticides containing organophosphorus and carbamate often have a short environmentalhalf-life—lastingonlyafewdaystomonthsasopposedtoyears—andtheirchemicaldegradation normally quickens with rising temperatures, pH levels, or other environmentalfactors(26).

Cause:

The inhibition of cholinesterase (ChE) enzymes invertebrate or vertebrate nerve systemsresults in the toxicity of OP and carbamate pesticides. Throughout the neurological system,these enzymes are involved in the normal transmission of nerve impulses. Acute pesticidedosagedecreasesChEactivity,impairingnormalnervempulsestransmission.This maycause mortality, generally from respiratory failure, and paralyse the neurological system (27).

Out of all the HCH isomers, 3-HCH was the most common isomer detected in birds and bats, indicating that it is more resistant to enzymatic degradation than the 0~- and y-isomers. Notably, compared to other birds and bats, resident and migratory birds such as crimson-crested barbet, brain fever bird, koel, gull-billed tern, and whiskered tern exhibited comparatively larger proportions of a- and y-isomers in flying fox, Indian pipistrelle bat, short-nosed fruit bat, and koel. This suggests that the birds and bats had recently been exposed to a technical HCH mixture that contained

70% ct, 15% y, 6% J5, and 9% 8-HCH, which is used in India (13).

Both carbamates and organophosphates are anti-cholinesterase substances. Acetyl cholinesterase inhibition causes intoxication by building up acetylcholine at the synaptic junction, which then triggers the activation of cholinergic receptors, causing respiratory damage and finally leading to death. These pesticides can be inhaled by birds, come into contact with their skin, and are mostly ingested by them through infected seeds or insects (1). Studies have shown that as agriculture has been more intensive and pesticide use has increased, the availability of invertebrates required to feed maize bunting chicks on farmlands has reduced (28).

Pesticide use over time disrupts the acetylcholine esterase enzyme, which causes alterations in bird posture. The other main impacts of these chemicals on birds are aberrant development, thinner eggshells, and changed tones in addition to these alterations in feeding behaviour. Most of the time, the effects are not immediate; instead, the pesticides are absorbed by worms and fish, which then pass on to birds via the food chain. Pesticides throw local species into mass extinction, upsetting the delicate balance of the ecosystem. Since aves are one of the main things that increase soil fertility through their droppings, a significant decline in wetland bird populations also affects agricultural output. This analysis will contribute to raising awareness among the various (29).

Droppings from Eurasian skylarks (*Alauda arvensis*), a species that typically feeds on winter cereal crops, during their autumnal migration. The birds were housed in paper bags until their physical conditions were determined, each bird was marked, and then they were released. The excrement left in paper bags to check for the presence of eighty pesticides, including degradation products and rodenticides (30).

Anorexia, gastrointestinal distress, and even a breakdown in the bird's capacity to distinguish between tainted and uncontaminated food are among the effects on feeding behaviour. Exposure to pesticides causes people avoid food, increases male and female hostility. Decrease in birds singing and showy behaviour. The reduced ability to lay eggs as a result of aberrant incubation behaviour, which also lowers the success rate of hatching impacts on a woman's reproductive habits (31).

Thermoregulation:

The pesticides induced reduction in body temperatures in birds are often associatedwith decrease inAchEacticity of more than 50%. It leads to enhancedmortality in birds is reported at sub lethal doses at thermo-neutral temperatures. Interaction between low temperature and pesticides toxicity appears to be resilt of theimpairment of thermoregulation causing inability of birds to withstand the cold (32).

Implications for physiology have an impact on thermoregulation. Make birds' body weight drastically decrease. OP causes transient hypothermia. It causes a drop in body temperature, making birds less able to tolerate the cold. Impact on the endocrine system and reproductive behaviour. Changes in gonadal development and reproductive behaviour. Delays in spermatogenic cell development and degeneration. Reduced number of degenerated germ cells in the seminiferous tubule is directly correlated with reduced levels of cholinesterase activity in the brain and testis of male birds. Decreased functionality of the testicles. Changes in LH and testosterone output along with a reduction in progesterone levels. Impact on the hormone feedback system (33)

Feeding:

Exposure to pesticides has a direct impact on eating behaviour, affecting how prey isencountered, selected, caught, and handled. hunting skills may be hampered by side effectssuch spasms, dizziness, and loss of coordination. Acute low-level exposure can result in long-termalterationstofoodhabits.Whenred-wingedblackbirds(*Agelaiusphoeniceus*)wereexposed to parathion-contaminated prey, they developed a taste aversion to the species ofprey, even in situations where the chemical was not present. This may lead to a decrease infoodconsumptionandconsequentlyinbodycomposition,butitmayalsolessenthechanceof food poisoning. (34).

Organophosphate and carbamate exposures affected the birds' capacity to distinguishbetweentaintedanduncontaminatedfood.Therewasalsoareductioninbodyweight,withan average weight loss of 14%, after sublethal exposure.A single dosage of dicrotophos wasassociated with this kind of weight loss.Pesticide-induced lesions in thelateral hypothalamus result in ffod avoidance and a marked decrease in body weight in birds(35).

Chronic effects:

The chicks were deformed, with deformed skletons and beaks, heart difficulties withfluid retention, and issues with determining sex. Following exposure to pesticides, tern chickshave been seen to develop feather growth problems and consequential abnormalities, whichmostlyaffecttheendocrinesystem.Becausetheyconsumelargeamounts of seed, birds are at a significant danger. Due to their weight loss,small birds. Endosulfan, an endocrine disruptor, and lindane bothalterbloodhormonelevels,whicharecrucialformetabolismandreproduction.Lowerhormone levels were linked to lower egg production (36).

Effect on haematological and immune system:

Afterbirdswereexposedtolindane,anaemiaandadropinhaemoglobinconcentrationwereobservedacorrelation between high prenatal pesticide exposure and the suppression of T-cell mediatedimmunity in wild Caspian terns and herring gulls (37).

Starvation:

The herbicides damage the habitat that the birds' prey uses, indirectly starve the birdsor drive them out of treated regions.For instance, artificial pyrethroids can ruin bird foodsources even though they generally have a minimal acute toxicity to birds. Particularly at riskare small insectivorous birds, waterfowl that feed on watery insects, and nestlings who eatinsects (38).

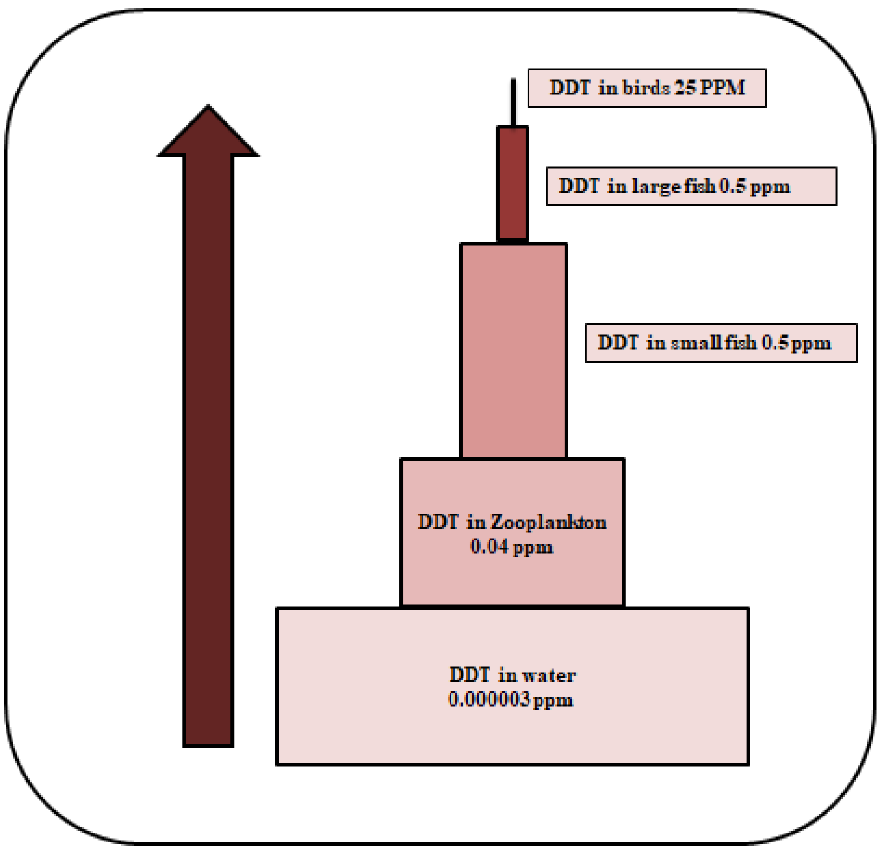

Fig 6.Biomagnification of DDT concentration

The biomagnifications and the bioaccumulation was mentioned in the above figure asthe waterhas lowest level of DDT concentration and it increases tremendously by migratory birds that exhibited higher BMFs for PCBs were the common red shank, gull-billed tern, long-billed Mongolian plover, pintail snipe, sandwich tern, white-cheeked tern, common sandpiper, and white-winged tern. The fact that most tern species biomagnified PCBs at higher levels than DDT and HCHs is concerning. This is consistent with a few studies that found higher PCB accumulation (39).

Pesticides have resulted in the decline in the abundance and diversity of invertebratesand plants. The effects of pesticides on the availability of chick food and thus nestlingsurvivalprospects(e.g.)Indirecteffectsaregenerallyconsideredtobethegreatestthreatfrom pesticides to birds (40).

Cholinesterase:

Cholinesterase-inhibiting insecticides, which include organophosphates and carbamates, leadto impaired nest attentiveness and predator avoidance. On wading birds productivity in USshowed that cholinesterase activity was low in some bird species nesting in an agriculturalestuary compared to non-agricultural ones.A review of evidence shows that cholinesteraseinhibiting insecticides can affect a range of physiological and behavioural patterns,potentially affecting individuals' survival and productivity in the field (41).

Fig7.Baldeaglewithclenchedtalon,asymptomofanti-cholinesterasepesticideexposure

Migratory birds:

Throughoutthewintermonths,awidevarietyofbirdsfromwesternAsia,Europe,and ArcticRussiavisittheIndiansubcontinent.Everywinter,hundredsofspeciesofwaterfowl homogenates of birds (42), but no reports of OC pesticideconcentrations in prey items or Indian bird eggs.

IPM:

RemedialMIntegratedPestManagement,orIPM,isaneffectivetechniquetomanage pests in your home and garden. By using IPM you can reduce the use of pesticides,havehealthierplants,andenjoyyourlandscape.ThesevenstepstheIPMincludesintroduction of Resistant varieties, Natural insect predators, Microbial pesticides, Controllingthe population, Non toxic naturally occurring substances and Synthetic pesticides in smallamounts (43).

Step 1. Prevention:

• Grow a range of species.
• Provide plants with the sunlight, water, and nutrients they require to grow healthy soil.
• Maintain tidy garden beds and walkways.
• Change up crop rotation measures

Step 2. Observation

• Keep a close eye on your plants.
• Maintain realism. Take just essential action.

Step 3. Taking Action

• Control measures

Step 4. Evaluation(44)

6. Conclusion:

By polluting food supplies, pesticides and their residues can have a direct orindirect negative impact on birds and their young. Pesticide exposure during the reproductivephases increases the likelihood of reproductive failure and has an impact on hatching successandfledgingsurvival.Theseissuesincludedmalignancies,aberrantthyroidactivity,behaviouralabnormalities,feminisationofmalesandfemales,thinningoftheeggshell,metabolic alterations, deformities and birth defects, immunological suppression, endocrinedysfunction, and reproductive dysfunction. Pesticide exposure, whether acute or chronic,raises mortality rates and has a negative impact on the avian population when it is sub lethal.Pesticide use is governed by international and national laws, which should be closely adheredto by users.

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