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DYNAMICS OF DETECTABILITY OF RESIDUAL AMOUNTS OF ORGANOCHLORINE INSECTICIDES IN SOILS AND WATERS OF THE MIDDLE REACHES OF THE ZARAFSHAN AND SURKHANDARYA RIVERS

Karimov Khusniddin Nagimovich
Research Institute of Horticulture, Viticulture and Winemaking named after Academician Makhmud Mirzaev
E-mail addresses: xkarimov1976@mail.ru

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Abstract:

The residual content of organochlorine pesticides in the soil and their movement along the trophic chain is proved by their detection in water and plants. Because it is established that the amount of pesticides in the arable layers of the soil increases by 2-4 times from the maximum allowable concentration (MAC), and to the lower layers up to 9 times.

Keywords: soil, water, plants, pesticides, food chain

LITERATURE REVIEW. The study assessed the prevalence of 76 pesticide residues in 317 samples of agricultural soil in the European Union. The soils were collected in 2015 from 11 EU member states and 6 major farming systems. Pesticide residues were found in more than 80% of the studied soils (1 residue in 25% of samples, a mixture of two or more residues in 58% of samples), a total of 166 different pesticide compounds [7; P. 1532-1545].

Residual amounts of organochlorine pesticides accumulate in soil, water and plants, move along the trophic chain and have a negative impact at the place of accumulation.

According to V.P.Vasiliev [1; p. 195], DDT accumulation does not occur in fruits (for example, apple trees), since water evaporation does not go through the fruits, but in the studies of H.T.Riskieva [4; p. 354-363], a high amount of DDT was found in fruits, tens of times higher than the amount of the drug in the soil. Experiments on cows have shown that the content of organochlorine insecticides in milk is proportional to their content in feed. It follows that the higher the background of pesticides in the diet, the higher the content of these drugs in adipose tissue and milk [2; pp. 7-13., 3; pp. 71-91].

Hexachlorocyclohexane (HCG), as well as DDT, is an insecticide of complex action, found in almost all components of the natural environment. It enters the atmosphere during aerial and ground pollination due to evaporation from treated surfaces. When using an aerosol generator, MAG for field processing is detected in the atmosphere at a distance of 5000 m at a concentration of 0.01 mg/m3. When using the HCG dust of 25 kg/ha, the average daily concentration in the surface layer of the atmosphere is 1.1 micrograms/m3 for 1 day, 0.5 for 2 – 0.33 for 3, 0.4 for 4; 0.4 for 5 micrograms/m3 [2; p. 7-13].

Data from Vera Silva et al showed that the maximum content of individual pesticides estimated in a soil sample was 2.05 mg/kg, and the maximum total content of pesticides was 2.87 mg/kg [7; P. 1532-1545], in a study by Govinda Bhandari et al. Pesticide residues were found mainly in the upper layer of the soil. In general, it was shown that pesticide concentrations range from 1.0 mcg kg-1 to 251 mcg kg-1, with an average of 16 mcg kg-1. [6; https://doi.org/10.1016/j. chemosphere. 2020.126594].

THE RESULTS OF THE STUDY. Studies conducted during the summer period have established a fairly high diversity of the content of organochlorine pesticides in soil and water. Thus, in many types of soils, organochlorine pesticides have not been detected or the detected amount of pesticides does not exceed the permissible norms or is at or below the MPC. At the same time, in the lower horizons of soils adjacent to the groundwater mirror, pesticides were found in quantities exceeding the MPC by 5-10 times.

In the ground, drinking and irrigation water of Ishtikhan (R-29, 22, 24) and Pastdargam districts, there are areas with exceeding the maximum permissible concentrations (MPC) of organochlorine pesticides (MPC in soil 0.1 mg/kg, in water 0.1 mg/l, in tobacco 0.7 mg/kg (according to data obtained from the Internet source) [9] up to 0.6 mg/kg (P-16) (Fig. 1-4).

In most cases, even with a low content of organochlorine insecticides in the upper, arable layer, there is a significant accumulation of these synthetic compounds down the soil profile.

For example, 0.072 mg/kg of HOP (P-5) was found in the arable horizon of old-irrigated gray-earth meadow soils, and in the 75-150 cm layer the amount of pesticides exceeded 0.8 mg/kg of soil and amounted to 8.0 MPC. In

the profile of newly irrigated gray-earth-meadow (Pastdargam district) light-loamy and highly saline soils, an increase in the residual amounts of pesticides in the lower horizons of the soil profile was also noted, even at a depth of 160 cm (P-18), at the junction with the groundwater mirror, the amount of α and γ HCG is 0.2 mg/kg of soil, which slightly exceeds the maximum-permissible concentrations. There is no particularly significant content of pesticides by seasons in dynamics and by year.

In the arable layer of newly irrigated typical serozems, organochlorine pesticides were not detected or are found in trace quantities, and in the layer of 148-200 cm bordering the groundwater mirror of section 15, residues of the gamma isomer of HCG in the amount of 0.4 mg/kg were determined, which exceeds the MPC by 4 times (Pastdargam district).

On old-irrigated meadow-alluvial soils, (in sections 24 and 25) on the border with groundwater, pesticides occur up to 0.3-0.2 mg/kg (Ishtikhan district).

The average amount of DDT metabolites in the arable horizon of the old-irrigated typical gray-earth soils of the Pastdargam district (times. 11) is equal to 0.002 mg/kg, in the 32-112 cm soil layer this amount is 0.03, and in the 61-150 cm horizon DDT reaches 0.065 mg/kg. The same pattern is observed in the 15 section of newly irrigated typical serozems, where the number of α isomers of HCG is equal to 1 MPC, and the amount of γ HCG is 4 times greater than the MPC, the number of metabolites of DDT and DDT is approaching the MPC.

In the arable layer of newly irrigated gray-earth-meadow soils of section 18, the amount of gamma HCG exceeds the MPC by 4 times. The presence of pesticides in newly irrigated typical serozem soils under vegetable crops reaches groundwater (85-205 cm) in the amount of 5 to 9 MPC and more (Fig. 1).

Significant amounts of pesticide metabolites have been identified in these soils. It should be noted that the composition of organochlorine pesticides is dominated by HCG with isomers, in which a significant amount of lindane occupies, which indicates a weak destruction of the insecticide in the soil conditions of the Zarafshan Valley or its fresh application. Slowing down the destruction of the insecticide can be caused by the accumulation of large amounts of water-soluble salts in the soil profile, which complicate the activity of soil fauna involved in the decomposition of the pesticide by consuming the carbon contained in the pesticide.

Reducing the decay of insecticides due to the consumption of carbon in the composition of the pesticide, in the context of soils is possible as a result of the accumulation of a large amount of water-soluble salts that complicate the activity of soil fauna involved in the dismemberment of the pesticide. Increased migration of pesticides along the soil profile and their accumulation in the lower horizons contributes to the penetration of pollutants into ground and surface waters.

In the waters of the Urgut district, the arithmetic mean value of the content of organochlorine pesticides in irrigation water is 0.3 mg/l and exceeds the MPC by 3 times, ground water contains pesticides, the amount of which exceeds the MPC by 2 times, artesian waters are polluted with pesticides 4 times higher than permissible values (Fig. 1).

The waters used for irrigation within the canal are free of organochlorine pesticides. Probably, the presence of pesticides in the water is due to their collection over the entire surface of the irrigated landscape.

On the territory of the Pastdargom district, only the waters of open irrigation facilities washing large areas of cultivated land are contaminated with HCG isomers, pesticides have not been found in the waters of the irrigation canal and groundwater.

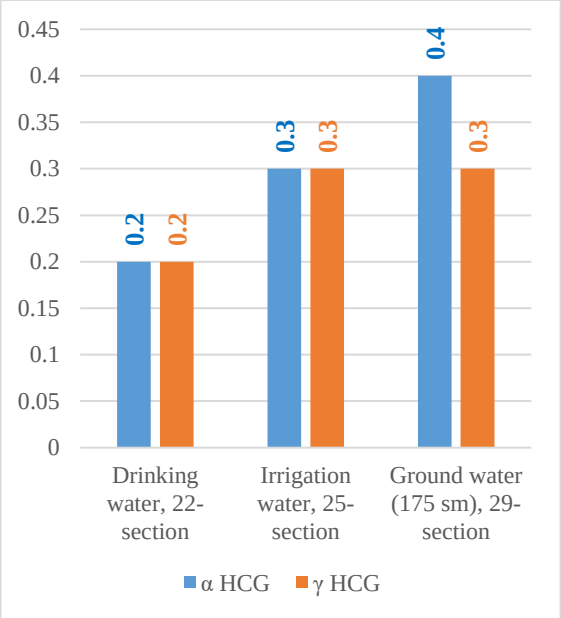
Toxically high amounts of HCG isomers were found in all waters of the Ishtykhansky and Narpai districts.

The analysis of the presence of pesticides in the soil, their spatial and vertical redistribution in it, their contamination of surface and groundwater, indicates a wide spread of pollution throughout the human habitat, when the penetration of pesticides into plant organisms becomes an objective reality.

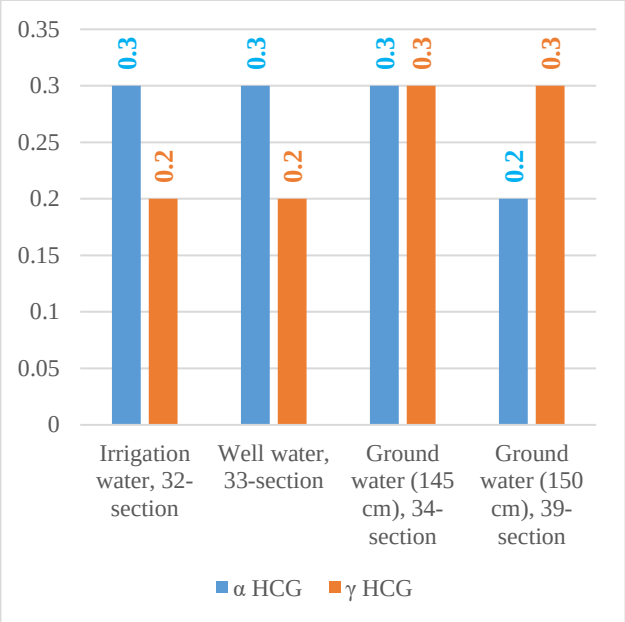
We will limit the consideration of the distribution of pesticides in various ecosystems to describing the degree of contamination of a separate link in the trophic chain – cultivated plants.

For example: in cotton fiber brought from the Ishtikhan district, the amount of α HCG was 0.6 mg/kg, γ HCG – 0.9 mg/kg, in tobacco plants taken from the (8 section) of the Urgut district, α HCG was 0.8 mg/kg, which exceeds the MPC by 1.14 times (MPC 0.7 mg/kg).

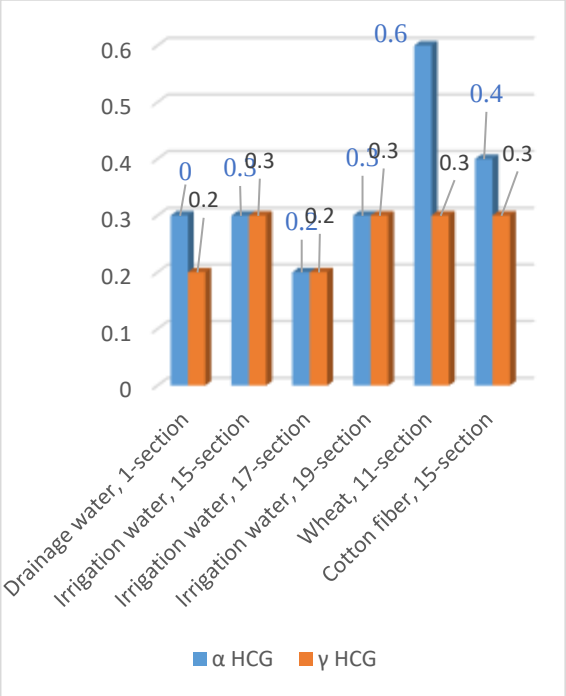
In relatively low polluted soil conditions, large amounts of pesticides are sometimes found. The reason for this, in our opinion, is the accumulation of pollutants in irrigation water. Large amounts of HCG isomers were found in almost all the studied cultivated plants (wheat, tobacco and cotton) (Fig. 1-4). Xenobiotics create chemical compounds with organic substances and mineral parts of soils, as a result of which the separation process with the soil worsens.



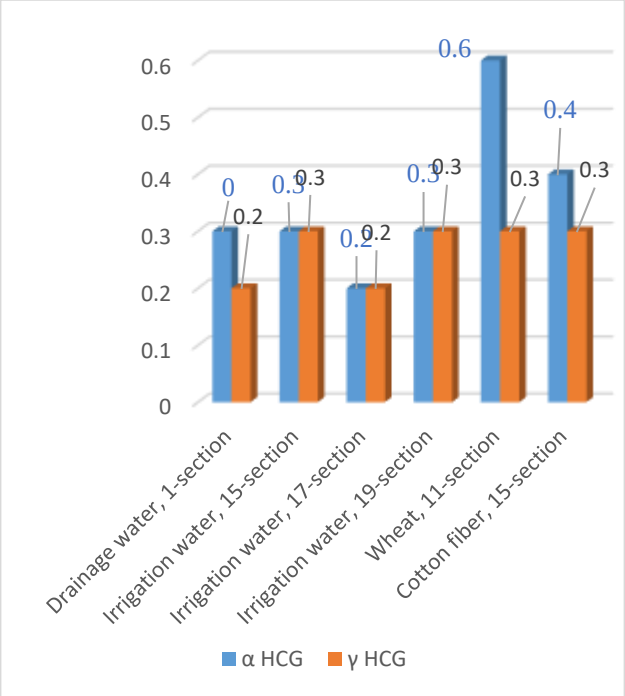
Picture 1. The content of HCH isomers in the waters of the Ishtikhansky district



Picture 2. The amount of organochlorine pesticides (OCH) in the waters of the Narpay region



Picture 3. The number of OCPs in the waters of the Urgut district



Picture 4. The amount of organochlorine pesticides (OCH) in the waters of the Narpay region

Despite the fact that soil contamination of the studied landscapes with residual amounts of organochlorine pesticides is insignificant and not ubiquitous, but it covers the entire soil column and is found in ground and surface waters in toxically high amounts, which has significant negative consequences. And one of them is the transfer and concentration of residues of persistent pesticides in cultivated plants, due to the ability of xenobiotics to penetrate from the soil into plants through the root system and tubers. There are quite a lot of examples of contamination of crop products with pesticides in the scientific literature [9] Xenobiotics, as active reagents and highly toxic substances, enter into chemical compounds with organic and mineral parts of soils, stop individual microorganisms, transform their activity, causing mutagenic phenomena, which leads to changes and disruption of ecological functions of soils.

At the same time, the influence of constantly used extractants – hexane and acetone - decreases. Pesticides do not pass into solution, and this leads to the conclusion that there are no pesticides in the soil. But the pesticide residues combined in the soil continue to have a toxic effect. In our opinion, in this case, the shoots of plants can perform the duty of the extractant. The largest particles of organochlorine pesticides were identified in the soils of the research areas. Pesticide contamination of waste, ground and drinking waters has been determined. The pesticides present in the composition of groundwater play the role of delivering new amounts of pesticides to the soil. Thus, the oppression

of irrigated soils of agricultural landscapes of the middle Zarafshan river under the influence of residual amounts of persistent organochlorine pesticides was determined.

This condition negatively affects not only the soil, but also all living things that exist in the aboveground and underground parts. In order to preserve the soil, nature, humanity needs to take measures to reduce the movement of toxic substances. For this reason, we conducted laboratory experiments in which a biotechnology was created to purify the soil and the environment from toxic substances, and also tested this technology in laboratory conditions.

Adsorption is an important process in the inactivation of xenobiotics, as a result of which the concentration of pesticides in the soil solution decreases and their movement and decomposition is limited. Dry soil adsorbs significant amounts of pesticides, the absorption strength increases with increasing soil dryness. During the irrigation period, the water absorbed by the soil begins to interfere with the intermolecular interaction of toxicants with soil colloids, the adsorption force weakens, pesticides move along the soil profile together with water, lingering in the lower layers of the soil, in conditions of automorphic soils, and penetrating into groundwater, in hydromorphic ones. In the inter–irrigation period, the reverse cycle of movement and partial decomposition of pesticides begins - they, due to the presence of near-earth air and high temperatures, are again concentrated (adsorbed) in the upper horizons of the soil profile. In our opinion, this is one of the main reasons for the long-term preservation of pesticides in irrigated soils.

The amount of residual OCPs (organochlorine pesticides) in typical serozem and takyr soils of Surkhandarya region has been studied.

It was found that the subthreshold concentration, which does not affect the saprophytic microflora of reservoirs and biological oxygen consumption, is 2.5 mg/l. This concentration at a 4-hour exposure does not violate the biochemical processes in the reservoir.

The maximum permissible concentration of OCP in the soil according to the Union SES is 0.1 mg/kg. Studies have shown that DDT normally 0.05 mg/kg of soil disrupts the course of biological and biochemical processes in irrigated soils, reducing their biological and enzymatic activity [5; pp. 9-10]).

Studies have established that the soils of the studied areas are polluted mainly by residual amounts of DDT and its persistent metabolite – DDE; alpha and gamma HCG occur fragmentally and in small quantities, they are found in the soils of the Sariosii district (P-20). In the arable and sub-arable horizons, the total number of HCG isomers reaches 0.01 and 0.008 mg/kg of soil, respectively. Sometimes the drug is found in the lowest horizon of the soil profile (P-112) and reaches 0.054 mg/kg.

In the old-irrigated typical gray soils of the Uzun district, DDT is accumulated in a layer of 0-56 cm (P–202), but is present throughout the profile: in the arable horizon – 0.112, in the sub–arable horizon – 0.326, in the layer of 56-87 cm - 0.008, in 87-106 cm - 0.004 mg/kg. The main pollutant is DDE. There are arrays with a very high content of toxic chemicals, in the range of 9.4-17.6 MAC (P-192, 133). The largest amount of pesticide can also be concentrated in the horizon B1 of section 192, where 1,762 mg/kg of DDT was detected.

The old–irrigated typical serozems of the Sariasi district are also contaminated with residual amounts of DDT, the main toxicant is a stable metabolite carrying the insecticidal properties of DDT. The largest amount of pesticides was found on the arrays characterized by sections 112, 122, 129. In these soils, the DDT content varies within 4.3-6.2 MPC, the penetration of the drug to the underlying rock is noted, reaching 2 MPC (P-122).

The irrigated massifs of the Denau district are less polluted with pesticide residues than the landscapes of the previously mentioned areas, here the highest content of xenobiotics reaches 2.6-3.4 MPC (P-261, 266, 257, 267). And in this area, the soils are polluted mainly by DDE, there is a penetration of insecticide into the deep layers of the soil and its accumulation in the illuvial horizon.

A significant presence of pesticides was also found in the soils of the Shurchinsky and Kumkurgan districts in all the studied objects, but in much smaller quantities than in the 3^x landscapes described above, the highest content is 1.4-2.3 MPC. At the same time, in our previous studies, a significantly higher content of pesticides was found in the soils of these areas.

In publications of 2000-2008 and scientific reports, we stated that pesticides, especially organochlorine, are not always extracted from the soil using reagents established by GOST (interstate standard) (hexane, acetone), the nature of their penetration into the soil absorbing complex, their interaction with organic matter, with soil colloids is still open.

According to the results of soil analysis, HCG and its isomers were not detected in the vast majority of sections, but according to leaf diagnostics, all cultivated plants are largely contaminated with the α isomer and partially with the γ isomer.

Table 2
The content of residual amounts of HOP by soil profile (arable layer)

Name of districts, type and soil	Section №	Depth, cm	OCP			
			β HCG	γ HCG	DDE	DDT
Suzunsky district						
Old - typical serozem soils	130	0-30	0	0,006	0,134	0
	132	0-30	0	0	0,398	0,026
	133	0-30	0	0	0,712	0,076
	134	0-30	0	0	0,062	0

	135	0-30	0	0	0,188	0,016
Sariasi district						
Old - typical serozem soils	126	0-30	0	0	0,078	0
	127	0-30	0	0	0,06	0
	128	0-30	0	0,006	0,186	0,02
	129	0-30	0	0	0,386	0,048
Denau district						
Old - typical serozem soils	256	0-30	0	0	0,112	0
	257	0-30	0	0	0,292	0,018
	258	0-30	0	0	0,054	0
	259	0-30	0	0	0,042	0
	260	0-30	0	0	0,042	0
	262	0-30	0	0	0,012	0
	263	0-30	0	0	0,004	0
	264	0-30	0	0	0,134	0,008
	265	0-30	0	0	0,016	0
	266	0-30	0	0	0,254	0,01
	267	0-30	0	0	0,260	0
Shurchinsky district						
Old Irrigated light serozem soils	268	0-30	0	0	0,172	0
	269	0-30	0	0	0,052	0
	270	0-30	0,0012	0	0,124	0,004
	271	0-30	0	0	0,006	0
	272	0-30	0	0	0,094	0,008
	273	0-30	0	0	0,070	0
	274	0-30	0	0	0,070	0
	276	0-30	0	0	0,230	0,012
	277	0-30	0	0	0,180	0,006
	278	0-30	0	0	0,112	0

Although significant amounts of DDE and DDT were found in soil samples, these metabolites were found in insignificant amounts in plants, most often they were not detected.

Thus, it can be stated that the soils of the studied areas are to a certain extent susceptible to the toxic effects of heavy metals. The soils of the belt of typical serozems experience a particularly noticeable load. The soils of the belt of irrigated light gray soils bear less load, the irrigated soils of the Kumkurgan district experience a weak effect of pollutants. Probably, the reason lies in the greater distance from the source of pollution – the Tajik aluminum plant.

The soils of all the studied areas are experiencing significant pressure from organochlorine pesticides. In order to obtain an accurate quantitative characteristic of the presence of pesticides, it is necessary to conduct conjugate analyses of soils and plants, moreover, a one-time determination may be erroneous, dynamic studies are needed. The most accurate information can be obtained at the autumn sampling period, when agrotechnical measures have been completed, the harvest has ripened, embodying all the processes that took place in the soil-plants system during the growing season.

The reason why HCG and its isomers were not found in soil samples, but were found in plant samples, in our opinion, is that HCG penetrated into the composition of soil colloids located around the root system of plants. In this case, DDT and its metabolites are located away from the root system. Conversely, if DDT is located next to the root system, then HCG and its isomers are removed from it. Residual amounts of organochlorine pesticides are found in all soils and objects of its environment, there is a transport of pesticides in the soil-water-plants system.

Based on the results of research in 2009-2011, we once again state our previous conclusion about the high mobility of organochlorine pesticides in soils, that it is not always possible to extract and measure the true amount of xenobiotics in soils using existing analysis methods. The results of this year's research once again confirm our thesis about the rather high seasonal dynamics of organochlorine pesticides in soils. The forms of organochlorine pesticides often change, either HCG isomers or DDT metabolites may prevail.

In the vast majority of the studied objects of the Sariasi district: Sufien, Kassirov, Bobur, Zarifboev, etc. the total amount of DDE and DDT is in the range of 1.3-3.0 MPC and, of course, has a negative impact on the quality of soils and the environment.

The analysis of waters and plants showed a high amount of pesticides in drinking and irrigation water and crop production, which confirms the validity of previous studies when plants grown on soils not contaminated with pesticides contained unacceptably high amounts of xenobiotics and became unusable. The maximum permissible concentration of organochlorine pesticides in water is 0.001 mg/l, in cotton - 0.02 mg/kg.

In the conditions of typical serozems of the Surkhandarya region, suffering long-term toxic pressure of TALCO emissions, even a low amount of pesticides, which theoretically should not have a toxic effect on the living phase of the soil and not adversely affect the nutritional regime of plants, there is an extremely high negative impact of xenobiotics on the ecological state of soils. The presence of HCG isomers and DDT metabolites in the leaves of vines and cotton in an amount of 0.01 mg / kg indicates the transport of pesticides along the trophic chain and the filling of protective barriers of the soil absorbing complex, and that the soil is in a situation where it loses the ability to self-purify.

Thus, the presence of toxic isomers and metabolites of residual amounts of organochlorine pesticides was detected in all studied soils. There is a promotion of pesticides in plants. However, on soils exposed to the toxic effects of TALCO emissions, this promotion is intensive due to the cumulative negative impact of a large number of pollutants. Soils that still do not tolerate high pressure of negative emissions are able to retain pesticides in various compounds and not pollute plants. It should be remembered that woody vegetation (walnut, mulberry) is able to extract pesticides from very deep layers of the soil profile and transfer them to the surface layers of the soil with a fall.

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