Recharge from precipitation and irrigation

Pumping of large volumes of water from aquifers has occurs each year. If the groundwater is not recharged periodically, the water table fall. Recharge occurs when precipitation is more than required in root zone. The water which enters the soil surface, passes via the root zone, and slowly percolates to the groundwater. In the surrounding area of Koshi River, part of the recharge water move into the aquifer. Even so, the recharge still comes from root zone drainage. Where the water table is declining, recharge occurs during wet periods. When root zone drainage occurs, part of the residual nitrate-N in the root zone is leached out and enters in the groundwater.

Cropping Practices (CP)

Maize production is recognized as a contributor to nitrate contamination of groundwater. In continuous corn production, the soil tends to store organic nitrogen from residues. This organic nitrogen is readily mineralizable, during the late summer and early fall, when the soil is warm. Mineralization added considerable amounts of mineral nitrogen to the soil after crop uptake is completed. This nitrogen is converted to nitrate and leached in off-season. The research finding has shown that a corn-soybean rotation can cut leaching as compared to continuous corn. Soybean is realised as a scavenger crop that uses residual nitrate-nitrogen in the soil before it fixes its own nitrogen. This reduces the amount of nitrate accessible for leaching during the growing season. Thus the management of water & recommended nitrogen fertilizer practices; result in reduction of nitrate-nitrogen contamination, depending on the soil & irrigation system. Considerably the sprinkler irrigation has the advantage that limited amounts of water can be applied and cause less in-season loss on medium to lighter textured soils.

Conclusions

Precipitation has a huge effect on drainage volume & nitrate losses. It is also affected by dry and wet climatic cycles with greatest losses in wet years. Nitrate losses are highly related to cropping system with row crops yielding greater drainage volumes & nitrate losses. Cover crop reduces nitrate losses. Rate of N application affects nitrate losses more than any other nutrient management. Nitrate losses increase with increasing N rate. The nitrate losses are different among N sources as long as application rate if it is coated with urea or lac while similar Management Practices are followed. Time of application affects nitrate losses but is greatly influenced by temporal distribution of precipitation and source of N. Side dress and late split applications tend to give greater nitrate losses in the succeeding year compared to spring preplant applications. Drainage water management and their depth, influences the volume of drainage and amount of nitrate lost. Nitrate loss, drainage volume, and discharge rate are increased with greater drainage intensity while nitrate and drainage losses are increased with deeper depths. Long-term, subsurface drainage, which integrates the effects of climate variability, soil properties and various cropping systems, is vital to nitrate losses.

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A way of Nitrogen management to reduce nitrate contamination in subsurface Waters

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The Bihar's eastern districts such as Madhepura, Purnia, Bhagalpur, Saharsa and Khagaria are popularly known as the 'maize hub'. Here maize is cultivated in around two lakh ha. In this area the application rates of nitrogenous fertilizer by the farmers often exceed the crop requirements, resulting in high nitrate accumulation in the soil. The impact of downstream nutrient export from agricultural fields continues to be of much more concern. Nitrate is particularly troublesome as it leaches through the soil into subsurface drainage or groundwater, which ultimately leads to surface waters. Permeable soils make the region susceptible to groundwater pollution by NO_3-N, which is applied to fields in large amounts as fertilizer. Nitrate that has accumulated in soils is highly prone to leaching, directly threatening the quality of groundwater.

Drainage Management Practices (DMP):

Research has been conducted on farmer's field to determine the effect of rate of Nitrogen (N) application and drainage management practices on nitrate losses from maize producing fields. The research finding has clearly shown that nitrate concentrations and losses in drainage water are primarily affected by the amount, temporal distribution and intensity of precipitation and cropping system, but N management (rate and time of application, source, and nitrification inhibitors) and controlled drainage management, spacing, & depth also play a significant role.

Rate of N applied in greater amount than needed, has a larger effect on N loss than time of application, source, or nitrification inhibitor. Interactions among these management practices coupled with hydrologic factors often add complexity to understanding N management relationships. Controlled drainage can reduce nitrate losses substantially, but needs to be synchronized with hydrologic factors and field operations to be most effective.

Time required for nitrate contamination to develop in aquifer

Nitrate contamination of groundwater has been emerging as a problem in recent years in some part of Bihar where the subsoil is sandy loam in nature and the water table is shallow (10 to 30 feet). Any nitrate leaving the root zone will reach the water table in a matter of weeks or at most a few months. While contamination problems may appear and then develop rapidly, better management of water and nitrogen should begin to improve groundwater quality for coming future.

Shallow groundwater travel time = few week to few months

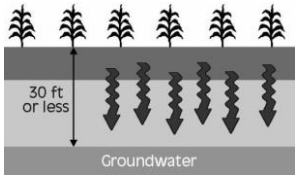


Figure.1. Shallow aquifer overlain by sand, the time required for nitrate to move from root zone to water table may be less than a year.

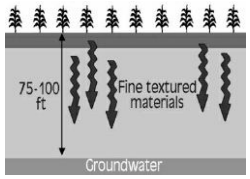


Figure.2. Deep water table overlain by fine Textured materials, many years required for nitrate to reach the Groundwater.

In the area, where the water table is deeper and is overlain by 80 - 100 feet of fine textured soil, the nitrate is beginning to be found in groundwater. In this condition there is a delay between nitrogen loss from the root zone and arrival in the water table. The Travel time from root zone to water table varying from 20 to 30 years.

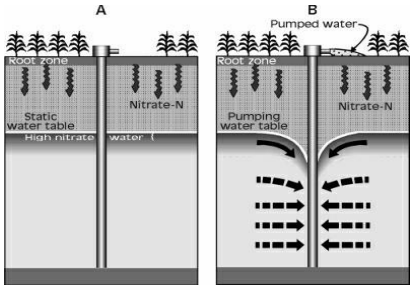
Deep groundwater travel time = 20-30 years

The groundwater contamination develops gradually for many years before it becomes apparent. Nitrate-nitrogen moving from the root zone to the groundwater arrives at the top of the water table and then very slowly mixes with the water below.

Nitrate-nitrogen movement and mixing in ground water

Nitrate-nitrogen moving from the root zone to the groundwater arrives at the top of the water table and then very slowly mixes with the water below. The water sample taken from irrigation well is a mixture of water entering the well from many depths in the aquifer. There may be considerable accumulation of nitrate in the upper groundwater, while the sample from the pumped well shows a much lower value that tends to represent an average over the aquifer depth.

The thicker the aquifer, the longer it takes for the concentration in the water to arrive at the 10 ppm.



Occurrence of nitrate loss

The nitrogen loss is unavoidable due to, the root zone, where most of the applied nitrogen fertilizer is converted eventually to the nitrate form through the microbial action and nitrate is readily dissolved in soil water, secondly, the root zone is relatively porous and leaky. When irrigation or rainfall increases, the water of the root zone, drain downward, carrying nitrate with it. In most cases, the nitrate eventually reaches the water table. Even under ideal conditions some nitrate-nitrogen is leached from both fertilizer nitrogen and that mineralized from organic matter in off-season rainfall. A loss has also occurred during the growing season if rainfall or irrigation is excessive or if nitrogen applications are excessive.