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Contrasting impacts of long-term application of manure and crop straw on residual nitrate-N along the soil profile in the North China Plain

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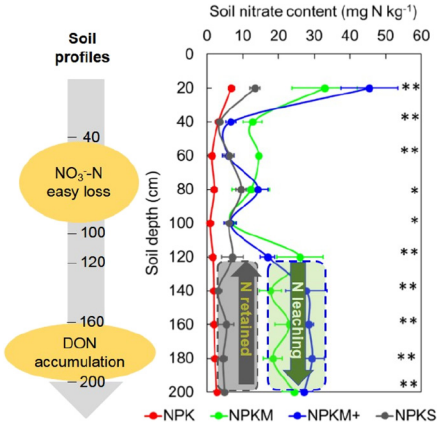
HIGHLIGHTS

- Soil organic C and total N contents were significantly enhanced after manure and straw added in the upper 20 cm.
- High nitrate-N contents found in deeper soil associated with manure addition may lead to a greater N leaching risk.
- Nitrate-N contents did not increase in deeper soil applied with straw N, indicating retention of NO_3^--N in the soil.
- In North China Plain, nitrate-N is readily to lose from the 40–100 cm layer of fluvo-aquic soil.

GRAPHICAL ABSTRACT



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ABSTRACT

The effects of long-term animal manure application and crop straw incorporation on the migration of carbon (C) and nitrogen (N) deep into the soil profile and the associated N leaching risk in particular have not been thoroughly elucidated to date. Soil profile samples were collected from depths of up to 200 cm from the following four treatments in a 27-year field experiment on the North China Plain: N + phosphorus (P) + potassium (K) fertilizers (NPK), NPK + 22.5 t ha^{-1} swine manure (NPKM), NPK + 33.7 t ha^{-1} swine manure (NPKM+) and NPK + straw incorporation (NPKS). The results revealed that long-term manure application and straw incorporation significantly enhanced the soil organic C (SOC) and total N (TN) contents in the upper 20 cm and that this effect was weaker in the deeper soil layers ($P < 0.05$). Residual nitrate-N (NO_3^--N) contents at 0 to 40 cm and 120 to 200 cm in the NPKM and NPKM+ were 4–16 and 2–9 times higher than those in the NPK and NPKS, respectively. These results indicated a greater potential for N leaching from manure addition and a higher propensity for NO_3^--N leaching out of the 40–100 cm soil layer. Pearson relationship analysis demonstrated that NO_3^--N content was clearly affected by SOC and dissolved organic N (DON) contents along the soil profile (20–200 cm), implying that the higher residual NO_3^--N contents in the deeper soil from manure addition were partially attributable to the mineralization and nitrification of the downward SOC and DON. Interestingly, a low level of residual NO_3^--N combined with negative mineralization in the 120–200 cm soil layers of the NPKS treatment was observed, suggesting that straw incorporation promotes soil NO_3^--N retention. Thus, we

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