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SUMMARY

A field study was conducted to determine the impact of tile drainage system on some nitrogen forms (NO_3^--N and NH_4^+-N), atrazine (a herbicide) and malathion (an insecticide) losses. The experimental site located at Fuwa district, Kafr El-Sheikh Governorate (North Nile Delta). The tile lines were installed in May 2002 and were spaced to simulate a 30 m and 60 m spacing and placed 1.2 m deep. The soil has a clayey texture, the field was plowed with moldboard plow to a depth of 20 cm.

In the summer season 2002, corn (*Zea mays* L.) was planted. Atrazine was sprayed to the soil surface at rate of 0.75 kg/fed during cultivation. Before the first irrigation, nitrogen was applied at rate of 120 kg N/fed (as urea). After corn planting, irrigation water was applied within one day after herbicide application.

In the winter season, wheat (*Triticum aestivum* L.) was planted. Malathion was mixed with the seeds at rate of 550 g/fed. After 50 days from wheat planting, 75 kg N/fed (as urea) was applied. To monitor water table heights and to collect ground water samples, observation wells were installed above drain and mid-way between each two drains at 1/8, 1/4 and 1/2 drain distance. Drain discharge rates were manually measured every day when drain flow occurred. Suction cups were installed in the field at 60, 90 and 120 cm depths. Several water samples from tile effluent, ground water and suction cups were collected at different times of the day and daily composite samples were takeu for analysis. Soil samples were collected at different times during the two growing seasons to determine; the pesticides, NO_3^- and NH_4^+, some physical and chemical properties. Also, some hydrological properties were measured. Grain and straw yields were determined. Grains and straw samples were taken for nitrogen analysis.

Obtained results can be summarized in the following points:

Some soil hydrophysical properties:

1. Water table levels increased rapidly with advancing time after irrigation. Water table levels above drains dropped faster than that in midway between drains. The drop was faster with 30 m drain spacing than with 60 m one. The mean values were 76, 60.8, and 80, 66.7 cm for the corn and wheat seasons in 30 m, 60 m spacing, respectively.
2. The rate of water table draw-down was decreased with increasing time after irrigation. This rate above the drains was higher than that in midway between drains. The rate is more clear under 30 m spaeing than 60 m.
3. Drainage intensity factor "a" values of tile draiued soil were high especially near the drain line. The spacing of 30 m was performed better than 60 m. The "a" values were increased by about 49.7 and 42.4% under 30 m than 60 m spacing for corn and wheat seasons, respectively.
4. Discharge rate "q" was decreased with increasing time after irrigation. Total discharge rates under 30 m spacing were higher by almost 337 and 217 m^3/fed/year for corn and wheat seasons, respectively as compared to 60 m spaciug.
5. Effective porosity above drains was higher than midway between drains, and was higher under 30 m than 60 m for both seasons.
6. The hydraulic conductivity increased with decreasing the distance from the drain line. The drained plots at 30 m spacing was performed better than that of 60 m. Also, the "K" values were lower in the second season than the first season.
7. Infiltration rate and eumulative infiltration can be arranged in the following order (above drains > midway drains 30 m > midway drains 60 m > before drainage installation). Values of basic

infiltration rate in 30 m spacing increased by about 50 and 60% for growing seasons of corn and wheat, respectively comparing with the 60 m one. Also, cumulative infiltration values in 30 m was increased by almost 23 and 21 mm for corn and wheat growing seasons, respectively, as compared to 60 m spacing.

8. The bulk density values increased with increasing soil depth, and were somewhat lower in 30 m as compared to 60 m spacing. Also, the values were somewhat lower for the second season than the first season. Soil porosity had almost the opposite trend to that encountered with bulk density.

Some soil chemical properties:

- Generally, the soil can be regarded as a normal non-saline, and non-alkaline. The EC values varied from 1.1 to 3 dS/m under different drainage conditions.
- Soluble sodium was the dominant cation compared to other soluble cations. After tile drainage installation, soluble Na^{+} was reduced under 30 m spacing and above drain line. While the changes in the values of Na^{+} were not clear under 60 m spacing. Soluble cations of Ca^{++}, Mg^{++} and K^{+} gaves the same trend of soluble Na^{+}. Soluble content of Na^{+}, Ca^{++}, Mg^{++} and K^{+} increased with increasing soil depth.
- Chloride (Cl^{-}) was the dominant anion compared to other soluble anions. The content of (Cl^{-}) took the same trend as obtained for the soluble Na^{+} nnder drainage conditions. The soil had not soluble carbonate and had low content of soluble bicarbonate. Sulphate (SO_4^{--}) was the second dominant soluble anion. The content of SO_4^{--} increased with iucreasing soil depth.
- SAR values were somewhat decreased in 30 m between drains and above drains than 60 m. The average values of SAR were 6.0, 5.31 and 5.5 after the first season, while, after the second season it were

6.2, 5.7 and 5.33 for midway between 60 m, 30 m and above drain, respectively.

- pH values ranged from 7.93 to 8.31 for all drainage conditions. The effect of tile drainage on values of pH was not clear. Also, pH values increased with increasing soil depth.
- Organic matter contents (OM%) decreased with increasing soil depth. OM content was slightly increased after drainage installation especially with the narrow drain spacing.

Movement of some nitrogen forms through the soil into subsurface tile drains:

1. Nitrate and ammonium contents of the soil under corn, decreased markedly with increasing soil depth. The high contents of NO_3^- and NH_4^+ were found after the first irrigation, and ranged from 28 to 59.5 and from 25 to 45.5 ppm for NO_3^- and NH_4^+, respectively. The low contents were found at the end of season and ranged from 11 to 28.5 ppm for NO_3^- and from 11 to 28 ppm for NH_4^+. Also, NO_3^- and NH_4^+ after the first irrigation decreased with the increasing of the distance from drain lines and the opposite trend was found at the end of the season. NO_3^- and NH_4^+ contents after the first irrigation were somewhat higher at 30 m spacing than 60 m one. At the end of the season, NO_3^- and NH_4^+ were nearly the same in both drain spacings.
2. Nitrate and ammonium contents of the soil under wheat decreased with increasing soil depth. The high contents of NO_3^- and NH_4^+ were found after fertilizer application (ranging from 21 to 53 and from 11 to 18 ppm for NO_3^- and NH_4^+, respectively). While, NO_3^- and NH_4^+ were reduced at the end of season (ranging from 9 to 19 ppm for NO_3^- and from 8 to 12 ppm for NH_4^+). After the first irrigation, NO_3^- and NH_4^+ decreased with increasing the distance from drain lines and the opposite trend was found at the end of the

season. NO_3^- and NH_4^+ after the first irrigation were lower to some degree under 30 m than 60 m. At the end of season, NO_3^- increased by 20% under 60 m than 30 m but, NH_4^+ nearly the same in both spacings.

3. Nitrate and ammonium concentrations in drainage water under corn reduced with time and ranged from 11.2 to 16.8 and from 5.6 to 11.9 ppm for NO_3^- and NH_4^+, respectively. After fertilizer application NO_3^- were somewhat higher under 30 m spacing (an average of 13.8 ppm) than 60 m (13 ppm) while, NO_3^- in the end of season was higher under 60 m than 30 m one. The estimated loss of NO_3-N was 23.2 kg/fed for 30 m and 17.5 kg for 60 m. Also, NH_4^+ was higher under 30 m than 60 m, but in the end of season was the same in both spacings. The estimated loss of NH_4^+-N was 15.3 kg fed$^-$ for 30 m and 8.5 kg/fed for 60 m.

4. Nitrate and ammonium concentrations in drainage water under wheat reduced with time and ranged from 9.1 to 14.7 for NO_3^- and from 2.5 to 4.9 ppm for NH_4^+. After fertilizer application NO_3^- was high significant under 30 m spacing than 60 m, while in the end of season NO_3^- was higher under 60 m than 30 m. The estimated loss of NO_3^--N was 10.7 kg/fed for 30 m and 7.1 kg/fed for 60 m. Also, the estimated loss of NH_4^--N was 3.5 kg/fed for 30 m and 2.4 kg/fed for 60 m spacing.

5. Nitrate and ammonium concentrations in ground water under corn, after fertilizer application, varied from 10.5 to 18.9 ppm for NO_3^- and from 3.2 to 9.1 ppm for NH_4^+. Also, NO_3^- was high significant under 30 m spacing than 60 m one. While, the differences in NH_4^+ contents were non-significant between both spaeings. In the end of season the coneentrations were reduced and, the mean values were 6.1, 6.8 and 3.7, 4.2 ppm for NO_3^- and NH_4^+ in 30 m, 60 m spacings, respectively.

6. Nitrate and ammonium concentrations in ground water under wheat, after fertilizer application, ranged from 9.5 to 14.7 and from 2.8 to 4.2 ppm for NO_3^- and NH_4^+, respectively. Also, NO_3- was high significant under 30 m spacing than 60 m. While, there was no clear difference in NH_4^+ content in both spacings. In the end of season, the concentrations were reduced and the mean values were 4.3, 5.4 and 1.9, 2.1 ppm for NO_3- and NH_4^+ in 30 m, 60 m spacings, respectively.
7. Nitrate and ammonium concentrations in the water of suction cups under corn reduced with time after irrigation and significantly reduced with increasing suction cups depth. Also, NO_3^- significantly reduced far from the drains, while NH_4^+ was no clear with increasing distance from the drain lines. NO_3^- and NH_4^+ concentrations during the growing season were increased significantly under 30 m spacing than 60 m one. The opposite trend was found with the NO_3^- in the end of season.
8. Nitrate and ammonium concentrations in the water of suetion cups under wheat reduced with time after irrigation and significantly decreased with increasing suction cups depth. Also, NO_3^- significantly increased above drain than midway between drain, while, NH_4 has no clear difference. In the 30 m spacing NO_3^- concentrations were significantly increased more than 60 m one, while, NH_4^+ was non-significant for both spacings (30 and 60 m).

Movement of atrazine through soil into subsurface tile drains.

Atrazine was already detected in subsurface tile flow within 1 day of pesticide application. This early arrival of atrazine to drains is consistent with concepts of preferential flow and non-equilibrium sorption/desorption. The loss of atrazine in drainage water was greater for 30 m drain-spacing plot than the 60 m one. Atrazine eoncentration in the soil decreased with soil depth and was higher between the drains than above the drain lines, and was higher under 60 m spacing than 30 m spacing. Atrazine was still present in the soil and in drainage water 15 days after application.

Movement of malathion through the soil into subsurface tile drains:

Concentration of malathion within one day of pesticide application was higher compared to after 15 days from application, this trend is consistent with concepts of discharge rate and preferential flow. The narrow drain spacing (30 m) had greater leaching loss of malathion to the drains than did the wide drain spacing (60 m). Malathion content in the soil decreased with soil depth and was higher between the drain than above the drain lines and also was higher under 60 m spacing than 30 m spacing. Also, increasing the time after irrigation led to reducing malathion content in soil.

Yields and N-uptake:

In relation to corn crop:

Yields and N-uptake of grains and straw were highly significant near the drains and decreased far from the drains. Grain yield from the 30 m spacing plots was significantly greater than the 60 m plots. Also, N-concentrations and N-uptake of grain and straw from 30 m spacing were significantly greater than the 60 m one.

In relation to wheat crop:

Yields, N-concentration and N-nptake of the grains and straw were significantly increased with decreasing the distances (L) from drain lines. Grain and straw yields were significantly increased under 30 m spacing than 60 m one. Also, N-concentration and N-uptake of grain were significantly increased under 30 m spacing compared to 60 m one.