IMPROVING IRRIGATION PRACTICE TO REDUCE RISK OF NITROGEN PERCOLATION INTO DEEPER AQUIFERS IN VEGETABLE CULTIVATION IN SUBURBAN HA NOI, VIET NAM

D.N. DANG[1], H.A. NGHIEM[2], T.T. NGUYEN[3], A.M. DANG[3], AND L.A. HA[3]

1) Vietnam Atomic Energy Institute (VAEI), Ha Noi, Viet Nam
2) Hanoi Institute for Fruit and Vegetable Researches, Ha Noi, Viet Nam
3) Institute for Nuclear Sciences and Technologies (INST), Ha Noi, Viet Nam

Outlines:

I. Background and Objective of the Study
II. Experimental Design
III. Findings and Comments
IV. Conclusions
V. Acknowledgement

I. Background and purpose of the Study

- Annually 2 mil tons of Urea, 0.6 mil ton DAP is used in agriculture in Viet Nam
- FUE is very low (less than 30%),
- Furrow watering is widely used method in vegetable cultivation in Viet Nam
- Eutrophication in SW and pollution in GW due to run-off.

The Objectives of the Study are:

- to compare WUE of cabbage watered by the traditional and drip with scheduling methods, and
- to elucidate the possibility of N-contaminant to percolate into groundwater in the two irrigation practices.

II. Experimental Design

-Plant: Cabbage-broad leave vegetable,
-Field: 450 m^2 area of ancient alluvial soil, split into 2 fields for experiment with furrow and with drip irrigation,
-Soil moisture: monitored using a neutron probe.

- Precipitation was recorded using a mini-meteorological station (Provantage 2) installed on the field
- Drip irrigation was constructed
- Water consumption in both the irrigation practices was recorded using water-meter (I, m^3),
- Rate of fertilizer applied: 10 ton chicken muck, N-P-K: 360:510: 270 kg per ha per crop season

- Soil samples were collected by profile using a corer

- NO_3^- and NH_4^+ in the soil samples was extracted and then analyzed for its concentrations on an IC (DIONEX 600)
- $\delta^{15}N$ (‰) in nitrate and ammonium was determined on an IR-MS (Micromass, UK)
- The cabbage was harvested 3 months after planting and its yield was recorded as edible (head: Y_{ed}, kg ha^{-1}) and total biological yield (Y_{bio}, kg ha^{-1}),
- Experiment was conducted for two seasons: A-W and W-S (2006-2007-2008)
- Technical WUE was calculated as:

$$WUE = \frac{Y_{ed/bio}}{I}, kgm^{-3}$$

III. What did we find?

III.1a. Irrigation practice and growth rate of cabbage

Irrigation practices	Time span from planting to …(days)			
	Recovery	Canopy formation	Head formation	Harvest
Furrow irrigation	12±3	42±3	55±2	95±4
Drip Irrigation with scheduling	12±2	42±3	54±3	95±3

Irrigation practice does not affect on the growth rate of cabbage

III.1b. Irrigation practice and parameters related to productivity of cabbage

Irrigation practice	H_{pl} (cm)	D_{can} (cm)	No. Green leaves	No. leaves in head	H_h (cm)	D_h (cm)
Drip method	26.6[b]	70.1[a]	18.5[a]	36.8[a]	13.1[a]	20.0[a]
Furrow method	29.3[a]	65.5[b]	19.3[a]	32.5[b]	12.4[b]	19.3[b]

H_{pl}: height of plant; D_{can}: diameter of canopy; H_h: head height and D_h: head diameter

Drip irrigation practice improved biological parameters of cabbage

III.2. WUE of cabbage

Irrig. Practice	In autumn-winter season				In winter-spring season			
	Plant density (plant m^{-2})	Y_E, (t ha^{-1})	Irrigated water, (m^3 ha^{-1})	WUE, (kg m^{-3})	Plant density, (plant m^{-2})	Y_E, (t ha^{-1})	Irrigated water, (m^3)	WUE, (kg m^{-3})
Furrow	2.6±0.4	37.7±0.5	25.10^3	**1.51±0.35**	2.7±0.3	35.8±0.7	22.10^3	**1.62±0.27**
Drip	2.5±0.4	39.2±0.3	$11.5.10^3$	**3.41±0.41**	2.5±0.4	36.1±0.3	$10.5.10^3$	**3.43± 0.35**

Drip irrigation practice could save up to 52-54% amount of water made the WUE to be improved to 2.2 times compared to that in the traditional furrow irrigation .

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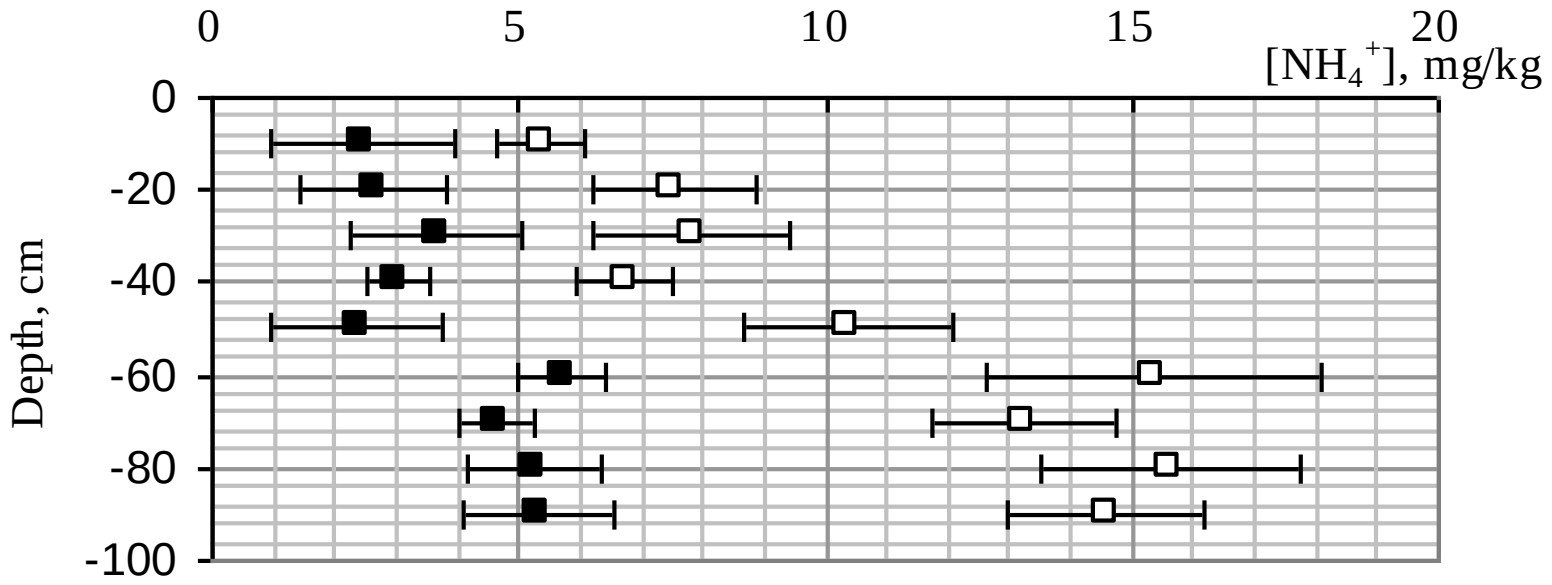
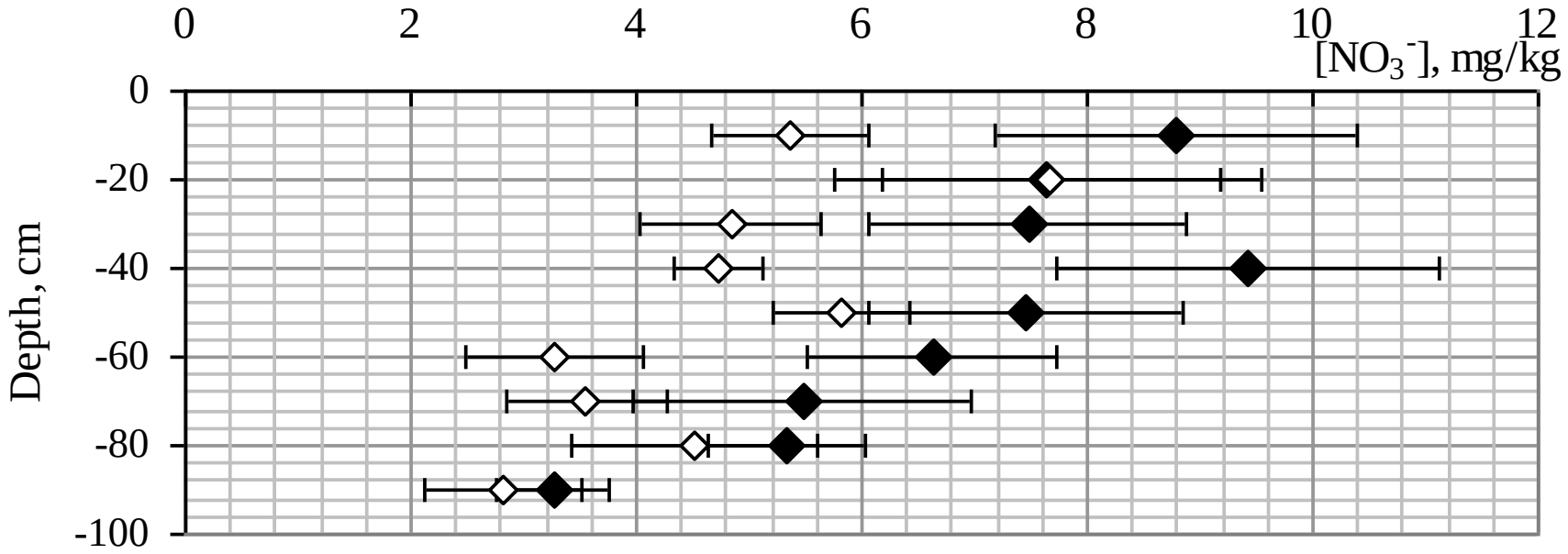
III.3. Distribution of N-contaminant along soil profile



Ammonium concentration along soil profile in **furrow irrigation**

(■) *NH_4^+ concentration before planting*
(□) *NH_4^+ concentration after harvesting (Autumn-Winter season)*

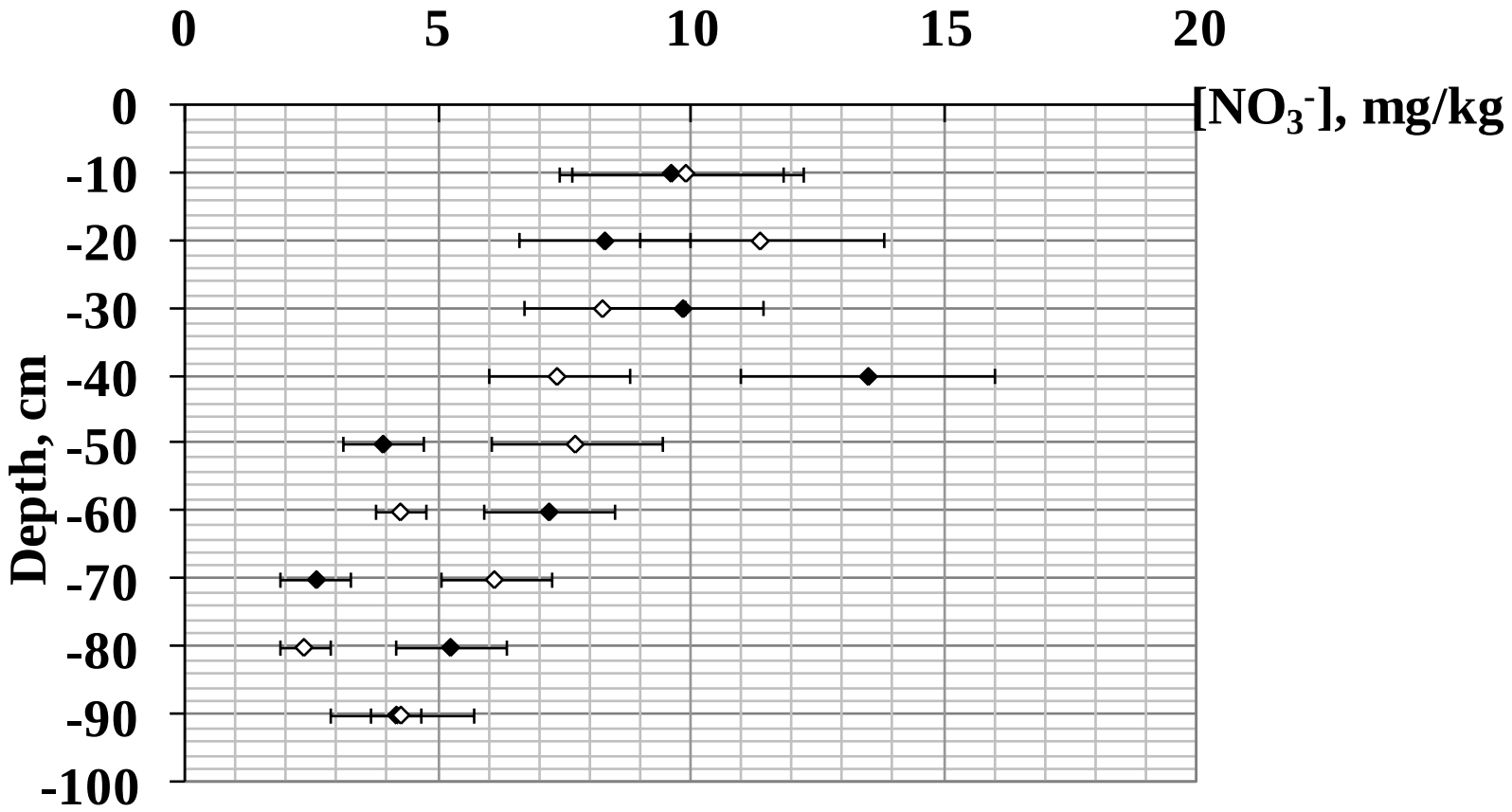
Ammonium percolated into deeper soil layer in the furrow irrigation.



Nitrate concentration along soil profile in **furrow irrigation**

(♦) NO_3^- *concentration (±1σ) before planting*
(◊) NO_3^- *concentration (±1σ) after harvesting (Autumn-Winter season)*

Nitrate seems not to percolate into the soil.

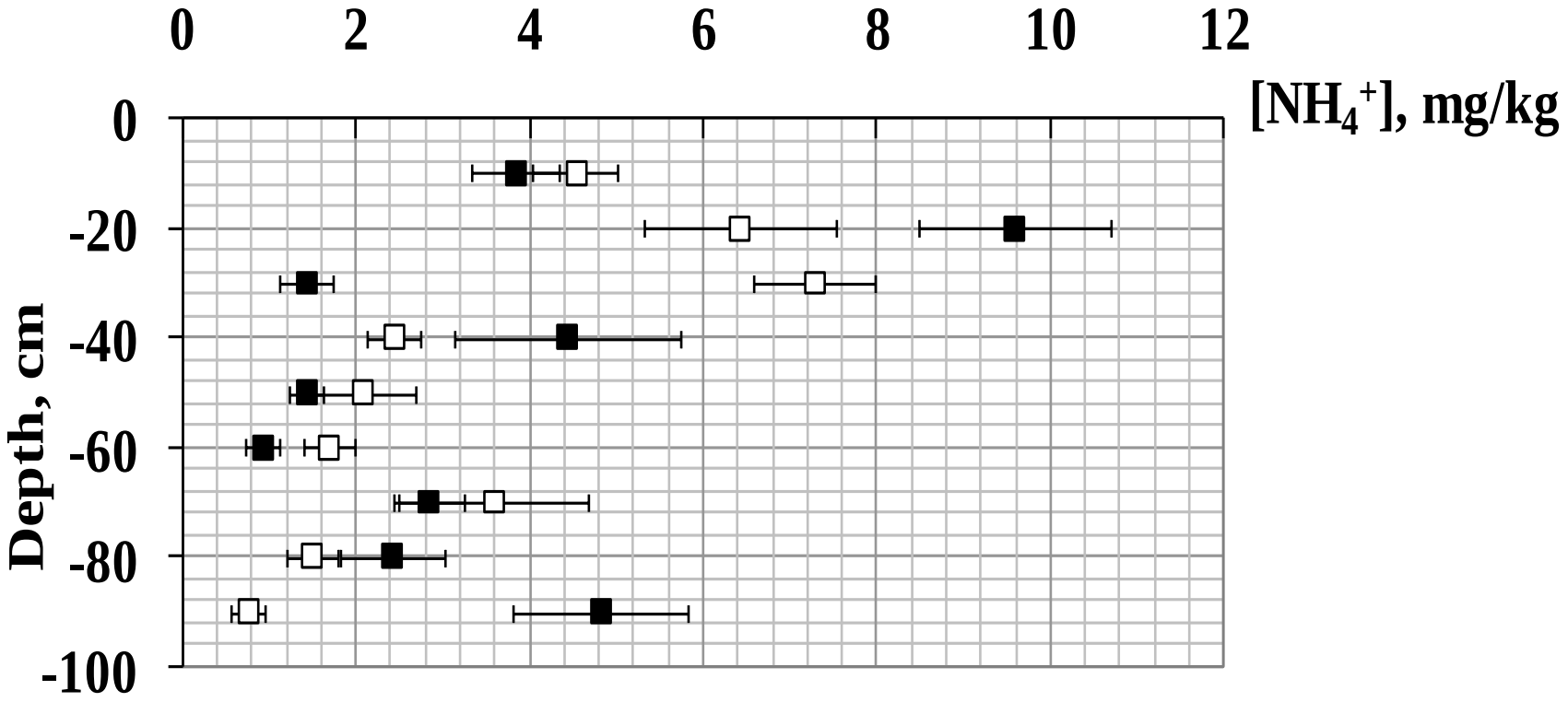


Nitrate concentration ($\pm 1\sigma$) along soil profile in **drip irrigation**

(♦) *NO_3^- concentration before planting*

(◊) *NO_3^- concentration after harvesting (Autumn-Winter season)*

Nitrate not to percolate into the soil in DI

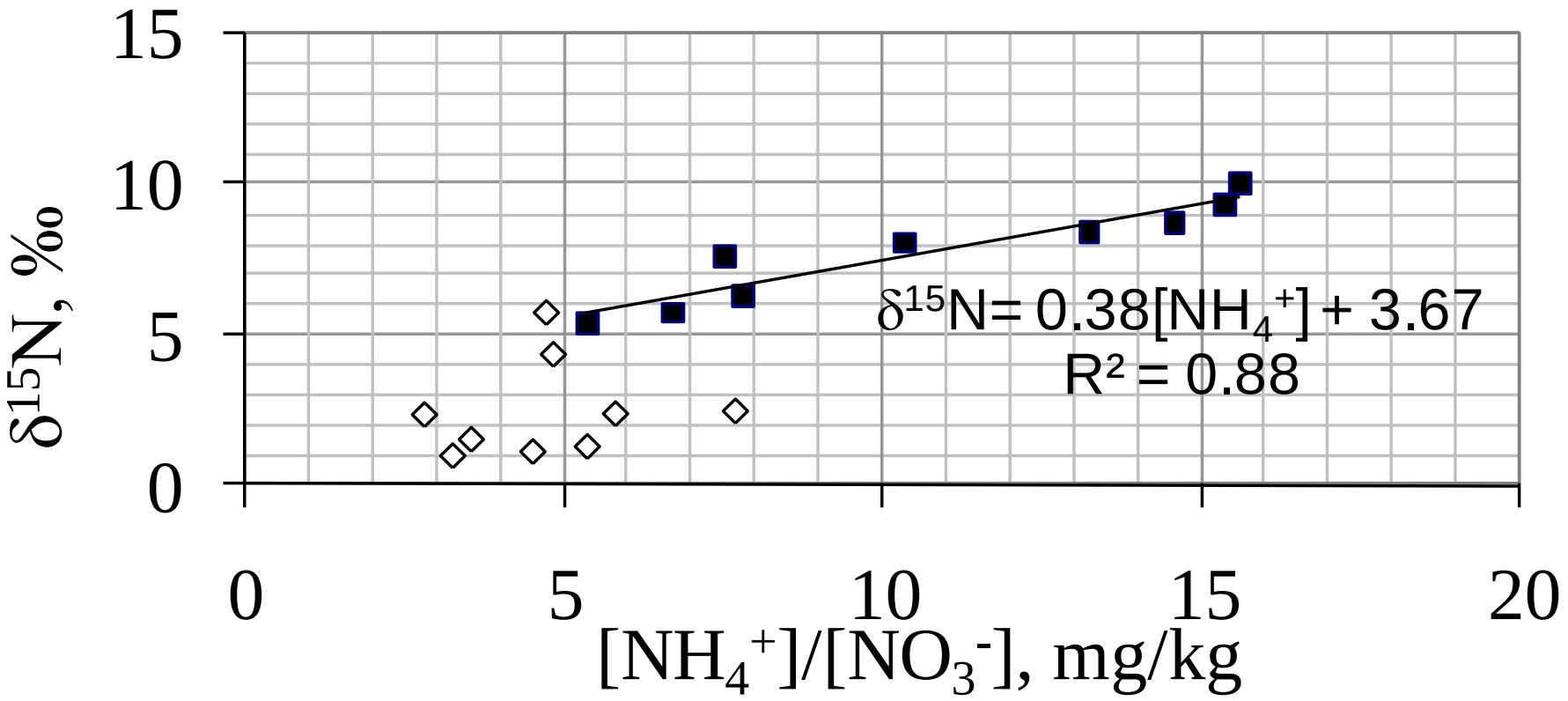


Ammonium concentration *(±1σ)* along soil profile in **drip irrigation**

(■) *NH_4^+ concentration before planting*

(□) *NH_4^+ concentration after harvesting (Autumn-Winter season)*

Ammonium not to percolate into the soil in DI

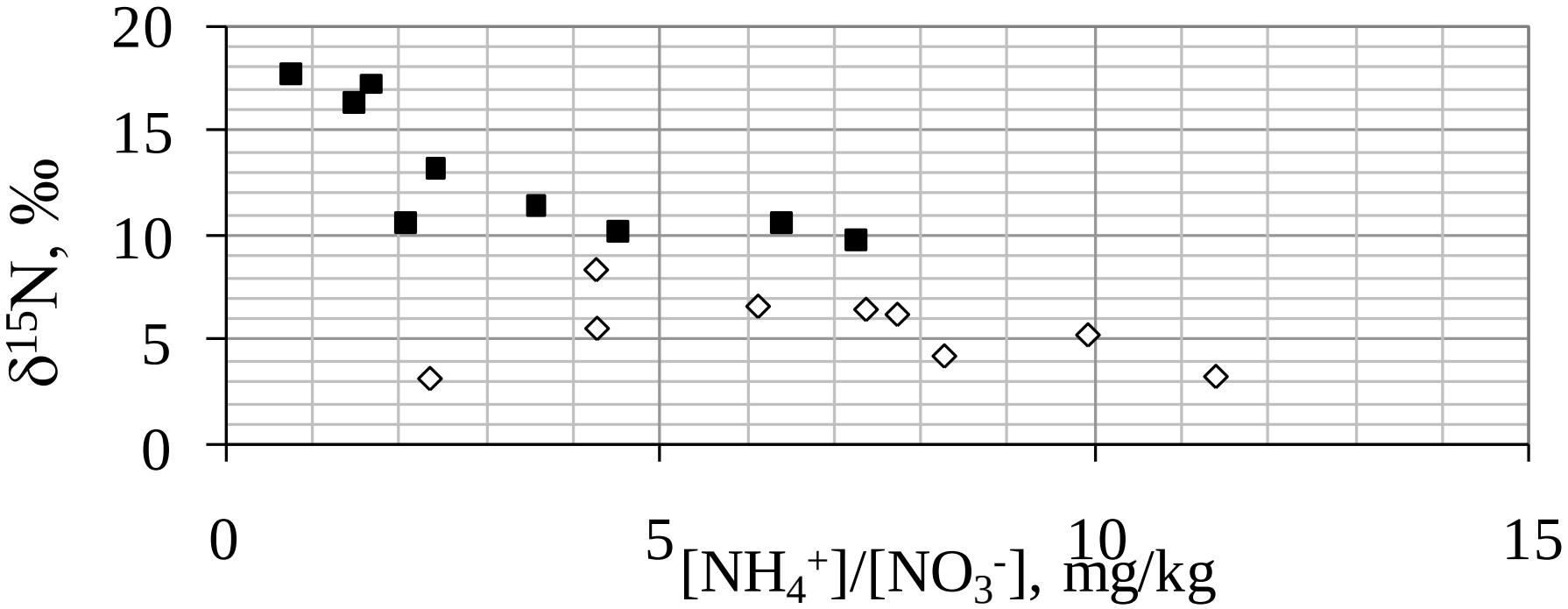


$\delta^{15}N$ (±0.2‰) *vs.* concentration of nitrate and ammonium in furrow irrigation

(◊) $\delta^{15}N$ in nitrate

(■) $\delta^{15}N$ in ammonium

Sources of NH_4^+ in soil **in FI** consist of more than 2, but that of NO_3^- is from inorganic fertilizer



$\delta^{15}N$ (±0.2‰) *vs.* concentration of N-contaminant in drip with scheduling irrigation

(◇) $\delta^{15}N$ in nitrate

(■) $\delta^{15}N$ in ammonium

NH_4^+ in soil in the DI is from the muck, but NO_3^- is from the inorganic frtilizers.

IV. Conclusions

1. Irrigation practice did not affect on the growth rate of cabbage: the span from rooting to canopy and head formation and to harvest was not dependent upon the watering practices;

2. On 651 ha (20% of land) for cabbage production in suburban Ha Noi city the local farmers could gain from DI an extra-profit amounted in around 300,000 USD a year at the same time around 8 million cubic meter of water could be saved.

Conclusions (cont.)

3. The traditional furrow irrigation practice applied on alluvial soil of the Red River facilitates ammonium to percolate into deeper than rooting zone soil profile causing risk to groundwater to be contaminated;
4. In traditional furrow irrigation practice, the dominant source of N-contaminant in soil seems to be from inorganic N-fertilizers;
6. Proper use N-fertilizer and management of irrigation water in agriculture should be given particularly attention in Viet Nam, in order to maintain highly productive crops on the one hand, but to minimize the risks of water resources deterioration cause by agricultural residues of percolating into groundwater, on the other hand.

THANK YOU FOR YOUR ATTENTION

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