

## SPATIAL VARIABILITY OF NITRATE IN CABBAGE AND NITRATE-N IN SOIL

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Long-term use of excessive nitrogen fertilizer contributes to the accumulation of nitrate-N in soil and, in turn, can lead to excessive accumulation of nitrate in vegetable crops. Better understanding of the spatial variability of soil nitrate-N and vegetable nitrate can provide a basis for site-specific soil nutrient management and for rational nitrogen fertilization rates combined with balanced fertilization for high quality, high yield vegetable production. This study was conducted to determine spatial variability characteristics of soil nitrate-N ( $\text{NO}_3^-$ -N) and nitrate ( $\text{NO}_3^-$ ) in cabbage and their interrelationship in a 55-ha vegetable production area using traditional statistics and geostatistics. The study area comprised 182 farm plots belonging to six production groups (recorded as 1st, 2nd, 3rd, 4th, 7th, and 8th groups). A total of 217 soil samples 0–20 cm in depth were collected on a 50 × 50-m grid in the study area before cabbage seeding. Prior to the cabbage harvest, 217 samples of edible cabbage parts were collected at sites corresponding to the soil sampling locations. The history of vegetable production at all of the soil sampling sites—including varieties, rotations, and fertilizer use—was surveyed, and soil nitrate-N and cabbage nitrate were measured. The spatial variability structure of nitrate content in cabbage and nitrate-N content in soil increased at first and then decreased with increasing separation distance. The spatial correlation ranges for cabbage nitrate contents and soil nitrate-N contents were 305.0 and 165.0 m, respectively, indicating the existence of significant spatial continuity in nitrate in cabbage and nitrate-N in soil. Notable spatial distribution comparability was observed in the contents of nitrate in cabbage and nitrate-N in soil. The contents of nitrate in edible cabbage parts and nitrate-N in soil were higher in most areas of Group 2 and Group 7 than in Group 1, Group 3, and Group 4; the contents were relatively lower in most areas of Group 8. Spatial variability of nitrate in cabbage was correlated positively with nitrate-N in soil ( $R^2 = 0.413^{**}$ ,  $n = 217$ ), whereas soil nitrogen-N contents were closely correlated with vegetable production history and nitrogen fertilizer application rates. (Soil Science 2004;169:640–649)

**Key words:** Nitrate in cabbage, nitrate-N in soil, spatial variability, GIS, nitrogen fertilizer use.

**V**EGETABLES have been found to accumulate nitrate. Up to 80% of nitrate taken into the human body may be from vegetable consump-

tion (White, 1975). The impact of nitrate on humans and the environment has been the subject of debate for many years. Excessive nitrate in the human body may affect human health as the nitrate can be reduced to nitrite through the activity of bacteria. High nitrite levels can lead to the oxidation of normal hemoglobin into high-iron hemoglobin, resulting in oxygen deficiency. Nitrite can also combine with secondary amines in the intestine and stomach to form the carcinogen nitrosamine, which may induce cancer of diges-

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