# OPTIMIZING OF NITROGEN FERTILIZATION UNDER DRIP IRRIGATION SYSTEM IN SANDY SOIL USING NUCLEAR TECHNIQUES


By

**AHMED EL SAYED FAHMY MOHAMED**

B.Sc. Agric. Sc. (Agricultural Engineering), Zagazig University, 2000

M.Sc. Agric. Sc. (Land and Water Management: Irrigated Agric.), Bari, Italy, 2006


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# ABSTRACT

**Ahmed El Sayed Fahmy Mohamed: Optimizing of Nitrogen Fertilization under Drip Irrigation System in Sandy Soil Using Nuclear Techniques. Unpublished Ph.D. Dissertation, Department of Agricultural Engineering, Faculty of Agriculture, Ain Shams University, 2016.**

Sand soil is characterized as poor fertile and no structured one therefore irrigation water may lose rapidly from the soil profile. Cultivation of such soils needs more attention to be paid for water and nutrient, especially nitrogen, management. In this regard, nitrogen management should provide an adequate supply for a crop throughout the growing season. If the amount of nitrogen is limiting at any time, there is a potential for loss in production. This work aimed to improve nitrogen efficiency as affected by irrigation water regime, N forms and rates (splitted doses). Therefore, a field experiment on sandy soil was conducted to trace the beneficial effects of urea and ammonium sulfate fertilizers added at different rates on pea growth and nutritional values as interacted with different water regimes. $^{15}$Nisotope dilution technique was followed to distinguish between the different N proportions derived to pea plants and in the same time estimating the efficient use of both two nitrogen forms (%NUE). Water regime and fertilization treatments were applied under surface drip irrigation system. Two water regimes represented 100% and 75% of water requirement in combination with three N fertilizer rates, i.e. $N_0$, $N_{100}$ and $N_{75}$ were applied.

The overall means of seed yield as affected by nitrogen fertilization treatments represent relative increase accounted for 45.8%, 38.7%, 41.7% and 36.2% over the unfertilized control for $Urea_{100}$, $Urea_{75}$, Ammonium $Sulfate_{100}$ and Ammonium $Sulfate_{75}$, respectively. It seems that 100% water regime (W1) made nitrogen fertilizer, especially with high rate, more available for plant uptake comparing to the low water quantity regime. Pea crop had accumulated more nitrogen from urea comparing to ammonium sulfate fertilizer. Nitrogen uptake, in general, significantly correlated to application rate.W1water regime in combination with ammonium sulfate fertilizer resulted in the best percentage or absolute values of N derived from fertilizer by pea seeds. It was clear that efficient use of ammonium sulfate, to some extent, doesn't affected by different water regimes. This holds true either at 100% or 75% application rates. On the other hand, urea added at rate of 75% was more efficiently used by seeds than those added at rate of 100% of the recommended rate.

Application of 75% of Etc (W2) treatment gave a remarkable yield and pronounced water saving therefore it is technically and economically recommended. For instant, the overall mean of water regime indicated that seed yield (2184.4 kg $ha^{-1}$) achieved by W1 (100%) was nearly closed to those obtained with W2 (75%) (2167.4 kg $ha^{-1}$).

**Key words:**

$^{15}N$, Irrigation Regimes, Nitrogen Fertilizer Form, Pea and Water use efficiency.

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# LIST OF ABBREVIATIONS

| Symbol | Name |
|---|---|
| **q** | = Discharge rate of emitter (lph) |
| **Kd** | = A coefficient specific to each emitter |
| **CV** | = Coefficient of manufacturing variation |
| $q_{avg}$ | = Mean emitter flow rate (lph) |
| **MD** | = Deviations of the single readings from the mean value, qm |
| **mu** | = Minimum emitter discharge of test sample operated at the reference pressure (lph) |
| **qa** | = Average emitter discharge (lph) |
| $H_m$ | = Minimum emitter operating pressure (m) |
| $H_a$ | = Average emitter operating pressure (m) |
| $Q_{12.5\%}$ | = Is the mean precipitation value in 12.5% emitters with the highest flow rate |
| **EU** | = Emission uniformity [%] |
| **R** | = The radius of the neutron sphere in cm |
| **θv** | = The volumetric moisture content expressed as % |
| **ETo** | = Reference evapotranspiration |
| **ETc** | = Crop evapotranspiration |
| **kc** | = Crop coefficient |
| **W1** | = Treatment 100 % ETc |
| **W2** | = Treatment 75 % ETc |
| **X** | = Mean discharge of emitters(l/h) |
| **S** | = Standard deviation of emitters discharge |
| **xi** | = Emitter discharge (l/h) |
| **n** | = Number of emitters |
| $Q_n$ | = Mean of the lowest quarter of discharge of the selected emitters (l/h) |
| $Q_a$ | = Mean of the total discharge rate (l/h) |
| $N_0$ | = without Fertilization |
| $N_{U100}$ | = 100% Urea Rate |
| $N_{U75}$ | = 75% Urea Rate |
| $N_{AS100}$ | = 100% Ammonium Sulfate Rate |
| $N_{AS75}$ | = 75% Ammonium Sulfate Rate |
| **Ndff** | = Nitrogen derived from fertilizer |
| **ds** | = Deficits of air humidity, mb |

**a, b** = Empirical coefficients of the regression equation
**tr** = Relative time

# INTRODUCTION

Due to irrigation water scarcity especially at semi-arid regions in addition to low fertility of sand soil, more efforts should be paid to achieve the proper scenario of water management and optimization of chemical nitrogen fertilizers for achievement of the best crop production with reduced water supply and fertilizer requirements.

In this respect, management of irrigation water and fertilizers plays vital roles for increasing productivity and quality of agricultural crops, as well as, application of appropriate technologies such as pressurized irrigation systems and chemigation which helps in improvement of water and fertilizers use efficiencies. Neutron scattering and $^{15}N$ techniques help for developing out the distribution of irrigation water in the soil profile, soil water and nitrogen fluxes, which helps to use water and fertilizers modeling under Egyptian conditions.

$^{15}N$ isotope dilution technique was followed to distinguish between the different N proportions derived to pea plants and in the same time estimating the efficient use of both two nitrogen forms (%NUE). Water regime and fertilization treatments were applied under surface drip irrigation system. Two water regimes represented 100% and 75% of water requirement in combination with three N fertilizer rates, i.e. $N_0$, $N_{100}$ and $N_{75}$ were applied.

The proper management of irrigation water and fertilizer resulted in increasing and improving of plant productivity and in the same time, minimizing the environmental hazardous impact. The proper management, in this respect, may induced an increase of water and/or fertilizer use efficiency (WUE % and FUE %).

The movement of water within soil profile is of great importance in utilizing, designing and managing of irrigation system networks. These processes are very dynamic, changing dramatically over time and space. Soil properties and water application rates interact in complex ways within the soil system to determine the direction and rate of movement of the water. Researchers have