obtained for the conventional N-fertilizer application treatment (N_{soil}) were higher than the same amount of N-fertilizer applied through fertigation (N_2), which showed that with fertigation treatment less N fertilizer was leached.

CONCLUSION

With this study it was proven that without any heating, one month early (first pick in June) and one month late (last pick at late October) tomato and pepper production is feasible under plastic greenhouse conditions in Ankara. Although early production for cucumber is feasible in the plastic greenhouse late cucumber production is not feasible.

It was shown that Yazgı F_1, Hızır F_1 and Serademre 8 are the suitable varieties of tomato, cucumber and pepper, respectively, for the plastic greenhouse conditions in Ankara due to their higher yields and % NUE values. It was also shown that nitrogen fertilization is necessary for the higher productivity of tomato, cucumber and pepper and with control treatments (N_0) nearly 24-58 % lower marketable fresh fruit yields were obtained compared to the yields obtained from N_3 or N_2 treatments. Also, soil application of N fertilizer (N_{soil}) was less effective when compared to fertigation treatment with same N rate.

REFERENCES

1. Moutonnet, P. and Heng, L.K. (2002) Overview of the IAEA programme on fertigation studies in the Mediterranean region. In Nuclear techniques in Integrated Plant Nutrient, Water and Soil Management. Proceedings of an International Symposium, 16-20 October 2000. Vienna, Austria. IAEA-C&S 11 and IAEA-C&S-11/C. pp. 217-234.
2. Halitligil, M.B., Akın, A.I., Kıslal, H., Oztürk, A., Deviren, A. (2002) Yield, nitrogen uptake and nitrogen use efficiencies by tomato, pepper, cucumber, melon and eggplant as affected by nitrogen rates applied with drip-irrigation under greenhouse conditions. In Water Balance and Fertigation for Crop Improvement in West Asia. IAEA-TECDOC-1266, pp. 99-110.
3. Zuraiqi, S., Qawasmi, W., Deek, I., Mohammad, M.J. (1998) Management of nitrogen fertigation of tomato with the use of ^{15}N technology. In Water Balance and Fertigation for Crop Improvement in West Asia. IAEA-TECDOC-1266 Vienna (2002) pp. 27-40. Handbook. IAEA-Vienna 48 p.

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NUCLEAR TECHNIQUES USED IN SOIL FERTILITY AND PLANT NUTRITION

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ABSTRACT

Nuclear techniques, which include the usage of radioactive and stable isotopes, had been used in soil fertility, plant nutrition, plant breeding, plant protection and food preservation research works after 1950s. Ultimately these nuclear techniques contributed greatly in increased plant production [1]. In general, it is possible to separate the nuclear techniques used in soil fertility and plant nutrition into to groups [2]. The first group is the use of radioactive and stable isotopes as a tracer in order to find out the optimum fertilization rate of plants precisely. The

second group is the use of neutron probe in determining the soil moisture at different periods of the growing season and at various soil depths precisely without any difficulty.

In research works where conventional techniques are used, it is not possible to identify how much of the nutrient taken up by the plant came from applied fertilizer or soil. However, when tracer techniques are used in research works it is possible to identify precisely which amount of the nutrient taken from fertilizer or from soil. Therefore, the nuclear techniques are very important in finding out which variety of fertilizer and how much of it must be used [3].

The determination of the soil moisture is very important in finding the water needs of the plants for a good growth. Soil moisture contents changes often during the growth period, so it must be determined very frequently in order to determine the amount of irrigation that has to be done. Conventional soil moisture determination (gravimetric method) is very laborious especially when it has to be done frequently. However, by using neutron probe soil moisture determinations can be done very easily any time during the plant growth period.

INTRODUCTION

With the discovery of isotopes at the beginning of this century and the developments after II. World War in isotope detecting and measuring instruments enabled the use of nuclear techniques in almost every branch of science extensively [2]. Isotopes have identical chemical properties (only slight mass differences) and they can be obtained in high specific activity for radioisotpes such as ^{32}P, ^{59}Fe, ^{54}Mn, ^{35}S or tracer abundance for stable isotopes such as ^{15}N, ^{13}C, ^{34}S. Stable isotope is better than the radio isotope in two respects, namely a) there is no radiation hazard and b) there is no term as 'half-life' for the stable isotope because the life of the tracer is infinite.

The nuclear techniques used in agriculture, in general, can be grouped in three categories such as: a) techniques that include the use of chemicals or compounds that are tagged with stable or radioisotopes, b) techniques that include the use of irradiation of the plants, seeds or food with different type of radiation χ-rays, α-alpha, β-beta and δ-gamma for obtaining improved varieties of plants, for preserving and increasing the shelf life of food and c) techniques for improving soil water management practices using neutron probe.

Nitrogen, phosphorous and water are the most critical factors that affect plant production and thus they are the subjects mostly researched in the world today[2,3,4,5]. The nuclear techniques that can be used for these three factors in research projects are ^{15}N, ^{32}P tagged fertilizer and neutron probe, respectively. Basic informations about these techniques and their applications will be given in this paper.

STABLE ISOTOPE ^{15}N TECHNIQUE

Nitrogen is consisted of two stable isotopes, ^{14}N and ^{15}N, and their isotopic composition is 99.634 and 0.366 atom percent, respectively. In other words, the natural abundance of ^{15}N is 0.366 atom percent. Nitrogen fertilizers can be enriched by special techniques [1,2] beyond natural abundance and the identification for this enrichment is made as % ^{15}N atom excess (%^{15}N a.e.). They are used in soil–plant research where N uptake by plant, residual N in the soil and leaching of N can be investigated directly. The use of a tracer of N is necessary in order to identify from which source N is coming. Isotope-derived criteria commonly used to interpret the results obtained from soil-plant nutrition studies fall into two groups and namely they are a.) yield-independent criteria (those values that require no estimate of plant yield since they are calculated directly from isotope dilution determinations). Percent of N in the plant derived from the fertilizer (% Ndff) is can be formulated as:

$$\% \text{ Ndff} = \frac{\%\ ^{15}\text{N a.e. (in sample)}}{\%\ ^{15}\text{N a.e. (in fertilizer)}} \times 100$$

b) yield-dependent criteria (those values which require estimates of the total plant yield, together with the determination of % N in the plan). Percent utilization of applied fertilizer nitrogen or nitrogen use efficiency (% NUE) can be formulated as:

$$\% \text{ NUE} = \frac{(\%\text{Ndff})[(\%\text{ N plant})(\text{yield of plant, kg/ha})]}{\text{Rate of fertilizer N application (kg N/ha)}}$$

This technique may be used in investigations dealing with a) Fertilizer N utilization, b) Fertilizer management practices (timing, rate, placement, source), c) Interactions with other factors (irrigation, plant variety, tillage), c) Fertilizer balance, d)Biological nitrogen fixation studies, e) Nitrogen turnover in the soil, f) Genotypic differences in nitrogen uptake and use, g)Distribution of applied N in soil organic matter, h) Recovery from crop residue, i)Distribution among plant parts, j)Nitrogen movement in the soil, k) Nitrogen gaseous losses (volatilization, denitrification), l) Nitrogen leaching losses, m) Environmental aspects of nitrogen use, n) Degradation of organic chemicals added to soils, o) Nitrogen metabolism studies in plants and animals and p) Distribution of N among plant parts.

RADIOISOTOPE ^{32}P TECNIQUE

Phosphorus has three isotopes of which one is (^{31}P) stable and the other two are β-beta emitting radioactive ^{32}P and ^{33}P with 14.3 and 25.0 days days of half life, respectively. The phosphorus isotopic composition, in other words, the specific activity (S.A.) is defined as ^{32}P/total P ratio [1,2,]. The determination of the specific activity of a sample requires two indewpendent measurements, namely they are: a) determination of the activity of the radioisotope by radio-assay techniques using detectors such as Geiger-Muller, liquid scintillation counting, cerenkov counting(for high-energy β emitters) or sodium-iodide scintillation detectors, and b) determination of the total P content by any conventional method. Specific activities of samples and fertilizer in becquerel (Bq) ^{32}P/gP, at the time the samples counted. Then the percent of P in the sample derived from ^{32}P labelled fertilizer is termed as % Pdff with the following formulation:

%Pdff = (S.A. plant sample/S.A.labelled fertilizer) x 100

and for the percent phosphorus use efficiency % PUE can be calculated by the following equation:

$$\%\text{PUE} = \frac{(\text{yield,kg/ha})\text{x}(\%\text{P})\text{x}(\%\text{Pdff})}{\text{Rate of P fertilizer applied, kgP/ha}} \text{ x } 100$$

This technique may be used in investigations dealing with a) Determination of the exchangeable P in soils, b) P availability from P fertilizers, c) Determination of the root activity and distribution, d) Residual P fertilizer in the soil, e) Diffusion of P in soils, f) Plant auto-radiography.

NEUTRON PROBE TECNIQUE

Determination of actual soil moisture at different sites, at different depths in the soil and with different irrigation management systems are necessary for the investigations on soil water and irrigation. Conventional soil moisture measurements (taking soil samples and determination of water in it gravimetrically whenever needed) were laborious and time consuming, however, to measure soil water in the field is much easier with neutron probe and it possesses many qualities such as simplicity, reliability, repeatability, cost-effectiveness, and this method is nondestructive. In neutron probe, fast neutrons are usually produced through (α,η), (β,η) or (δ,η) reactions, and these fast neutrons collide with atoms in the soil environment [2]. However, only after colliding with H atoms, which has a nucleus of about the same size and mass as the neutron, the slow neutrons are produced and they are measured with a detector, and then the data is calibrated against water content on a volume basis in the soil. This phenomenon is used as a base to measure soil water content with neutron probe technique using the assumption that all H atoms stem from water molecules in the soil. Therefore, calibration of the data measured with this technique must be made with gravimetrically obtained soil water data in order them to reflect the real water status found in the soil.

This technique may be used in investigations dealing with a) Water use efficiency determinations of plants, b) Field irrigation efficiency determinations, c) Determination of the water uptake trends of the plant root at different environments, d) Determination of the effects of rotation and soil cultivation on plant water uptake.

REFERENCES

1. Danesi, R.R. 1992. Nuclear Techniques and Sustainable agricultural development. IAEA Bulletin. Vienna, Austria.Vol. 34, No. 4, page 2-8.
2. IAEA, Use of Isotope and Radiation Methods in Soil Water Management and Crop Nutrition. Manual. FAO/IAEA Agriculture and Biotechnology Laboratory, Joint FAO/IAEA Division on Nuclear Techniques in Food and Agriculture, Vienna, 2001. Training Course Series No.14. pp. 247.
3. Halitligil, M.B., Akın, A., Aydın, M., Yılmaz A. and Dönmez, Ö. (1996). Effects of legumes, fallow and wheat on subsequent wheat production in Central Anatolia. Nuclear methods for plant nutrients and water balance studies. IAEA-TECDOC-875: 53-62.
4. Halitligil, M. B., Akın, A., Kışlal, H., Öztürk, A., Deviren, A.(2002) Yield, nitrogen uptake and nitrogen use efficiency by tomato, pepper, cucumber, melon and eggplant as affected by nitrogen rates applied with drip-irrigation under greenhouse conditions. In Water balance and fertigation for crop improvement in West Asia. IAEA-TECDOC-1266, page 99-110.
5. Halitligil, M. B., Akın, A., İlbeyi, A. (2002) Nitrogen balance of nitrogen-15 applied as ammonium sulphate to irrigated potatoes in sandy textured soils. Biology and Fertility of Soils Vol. 35 : 369-378.

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INTERNATIONAL STANDARDS AND AGREEMENTS IN FOOD IRRADIATION

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ABSTRACT

The economies of both developed and developing countries have been affected by their exported food and agricultural products. Trading policies of food and agricultural products are governed by international agreement as well as national regulations.Trade in food and agricultural commodities may be affected by both principal Agreements within the overall World