Tensiometer and neutron probe readings for each vegetable were taken at different soil depths just before each irrigation in 2002 and 2003 experiments; the suction, in mbar, that water held by the soil and soil moisture content, in mm, were calculated. Highest tensiometer readings were obtained for 15 cm soil depth for tomato and pepper, except in early August for which the highest was obtained for 30 cm soil depth. Tensiometer readings taken from 45-60 cm soil depth did differ very little, which can be seen from the figures, indicated that almost no water movement had occurred below 60 cm depth.

For tomato soil moisture content at different depths and rates (N_0 and N_3 fertilizer treatments) showed very little differences monthly, although the total moisture content in the 0-90 cm soil profile showed considerable differences. However, for cucumber and pepper soil moisture contents at different depths and rates (N_0 and N_3 fertilizer treatments) showed considerable differences monthly beside the total moisture content in the 0-90 cm soil profile.

CONCLUSION

Significantly higher yields and WUE values were obtained when the same amount of N fertilizer is applied through fertigation compared to the treatment where N fertilizer applied to the soil then drip irrigated. The nitrate concentrations of the soil solution increased as the N rates increased and no NO_3 had been found in the soil solution taken from 75 cm soil depth, indicating that no leaching of N fertilizer occurred beyond 75 cm soil depth.

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NITROGEN UTILIZATION OF VEGETABLES GROWN UNDER PLASTIC GREENHOUSE IN ANKARA CONDITIONS USING ^{15}N TECHNIQUE

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ABSTRACT

In order to find suitable varieties of tomato, pepper and cucumber for plastic greenhouse conditions in Ankara and eventually to identify the best N fertilizer rate greenhouse experiments were conducted for two years. Yazgı F_1 variety for tomato, Hızır F_1 variety for cucumber and Serademre 8 variety for pepper were chosen to be the suitable varieties to grow in the plastic greenhouse conditions in Ankara.

Five N treatments [N_0 = 0, N_1 = 150, N_2 = 300, and N_3 = 450 kg N/ha; also, soil N application treatment (N_{soil}) equivalent to the fertigation treatment of 300 kg N/ha was included for tomato and pepper, however N rates for cucumber was 131, 266 and 339 kg N/ha; N_{soil} being 266 kg N/ha.] were investigated using ^{15}N labeled urea ferilizer.

Significantly higher marketable fresh fruit and total dry matter yields and N uptakes values were obtained from N_3 treatments for tomato and cucumber, but from N_2 treatment for pepper. Also, significantly higher yields, N uptakes and % NUE values were obtained when the same amount of N fertilizer is applied through fertigation compared to the treatment where N fertilizer applied to the soil then drip irrigated.

INTRODUCTION

The plants can use nitrogen easily and more efficiently if they can exist at optimum levels in the effective root zone of the plants. Drip irrigation-fertigation is the system that can provide both nitrogen and water at desired levels and conditions in the root zone. Both yields, nitrogen and water use efficiencies can be increased by drip irrigation-fertigation [1,2,3]. This system had been as a sensible method of supplying nitrogen inside the greenhouse [2,3]. Plastic greenhouses without heating systems had been widely used in the Mediterranean and Agean Sea Regions of Turkey successfully during the last decade for drip irrigated–fertigated vegetable production [3]. However, plastic greenhouses are recently had being used for vegetable production at temperate locations of Central Anatolia, like Ankara, without the need of any additional heating in cool weather (early April – late October). In general, open field vegetables are produced and sent to market in mid July in Ankara. To grow vegetables earlier then July in Ankara climatic conditions will be an extra income to the farmers due to selling their vegetables for higher prices.

The specific objective of this study was to compare the nitrogen fertilizer use efficiency under conventional N fertilizer application with N fertigation when drip irrigation system is used in the greenhouse conditions in Ankara.

MATERIAL AND METHODS

In order to to find out the suitable varieties of tomato, pepper and cucumber for plastic greenhouse conditions in Ankara, four different varieties from each vegetable, namely, Tomato (Ecem F_1, 9920 F_1, 2116 F_1 and Yazgı F_1), Cucumber (Hızır F_1 , Rapido, Hana, and Luna) and Pepper (1245 F_1, 730 F_1, Serademre 8 and 710 F_1) varieties were grown in the plastic greenhouse of Ankara Nuclear Research Center for Agriculture and Animal Sciences (ANRCAAS) at Saray-Ankara in 2001. Due to the higher marketable fresh fruit and total dry matter yields, N uptakes and NUE values obtained from Yazgı F_1 , Hızır F_1 and Serademre 8 varieties for tomato, cucumber and pepper, respectively, were chosen to be used in 2002 and 2003 experiments.

The soil used in the experiment had a pH of 7.9 and was low in organic matter content. Greenhouse was divided into three sections and in each section there were two 70 cm wide ridges and in between the ridges there was one 70 cm furrow for each vegetable. For every vegetable section there were four rows and at each row plants were 70 cm apart which ended up with a plant density of 20 000 plants per hectare. Five N treatments were investigated in all experiments. Nitrogen as urea was applied through drip irrigation water at rates of N_0 = 0, N_1 = 150, N_2 = 300, and N_3 = 450 kg N/ha; also, soil N application treatment (N_{soil}) equivalent to the fertigation treatment of 300 kg N/ha was included for tomato and pepper, however N rates for cucumber was 131, 266 and 339 kg N/ha; N_{soil} being 266 kg N/ha.

Each vegetable experiment consisted of two blocks in which the five N treatments plots were established in a randomized complete block experimental design. Therefore, each N treatment plot consisted of two rows having 8 plants (2.8 m x 1.4 m = 3.92 m^2) at planting. The middle four plants were considered to be the replications and each of them was assigned with a

replication number. ^{15}N isotope subplots were established on each ridge including 8 plants with a different lateral dripper line. Urea fertilizer with % 1,61 ^{15}N atom excess enrichment was used.

At final harvest, each assigned replication plant from each plot was harvested separately and divided into fruit, leaf, stem and root parts, then dried at 70 °C, ground and passed 2 mm screen. Total N and ^{15}N analyses were done by using semi microKjeldahl and NOI7 emission spectrometer, respectively. Afterwards, Ndff and NUE values were calculated.

RESULTS AND DISCUSSION

Two year average values of yield, N uptake, nitrogen use efficiency (% NUE) for tomato variety Yazgı F_1, cucumber variety Hızır F_1 and pepper variety Serademre 8 at different N rates are given in Table 1.

Significantly higher marketable fresh fruit and total dry matter yields and N uptake values were obtained from N_3 treatments for tomato and cucumber, but from N_2 treatment for pepper. Significantly lower % NUE values were observed by decreasing the N rate, which is in accordance with the findings of other researchers [2,3]. Highest % NUE values were obtained for cucumber and the lowest values obtained for tomato. For all three vegetables the lowest marketable fresh fruit and total dry matter yields, N uptakes values were obtained when no N fertilizer applied (N_0 treatment).

Table 1. Two years average total yields, N uptakes, Ndff and % NUE of vegetables grown at different n treatments under plastic greenhouse conditions.

	N Rates				
	N_0	N_1	N_2	N_3	N_{soil}
TOMATO (Yazgı F_1) Fresh Fruit Yields (kg/ha)	146500 c	170000 ab	174930 a	181270 a	165630 b
Total Dry Matter Yields (kg/ha)	10003 c	11681 b	11692 b	12383 a	11402 b
Total N uptake (kg N/ha)	159 d	186 c	204 b	222 a	205 b
Ndff (kg N/ha)		44 d	79 b	110 a	73 c
% NUE		28.9 a	26.4 b	24.5 c	24.2 c
CUCUMBER (Hızır F_1) Fresh Fruit Yields (kg/ha)	107880 c	148100 b	157750 b	170400 a	154230 b
Total Dry Matter Yields (kg/ha)	7937 d	9797 c	10301 b	10535 a	10130 b
Total N uptake (kg N/ha)	158 d	202 c	242 a	250 a	222 b
Ndff (kg N/ha)		79 c	125 b	155 a	83 c
% NUE		59.8 a	47.6 b	39.3 c	31.7 d
PEPPER (Serademre 8) Fresh Fruit Yields (kg/ha)	72350 e	83100 d	111230 a	99250 b	89430 c
Total Dry Matter Yields (kg/da)	8155 d	10736 c	13175 a	12478 b	10860 c
Total N uptake (kg N/ha)	175 e	206 d	300 a	262 b	230 c
Ndff (kg N/ha)		47 d	106b	125 a	79 c
% NUE		30.5 b	36.5 a	28.8 bc	26.6 c

* Values followed by the same letter within a row are not significantly different at 0.05 levels according to LSD analysis.

Significantly higher yields, N uptakes, % NUE values were obtained when same amount of N fertilizer (N_2 treatment) is applied through fertigation compared to the treatment where N fertilizer applied to the soil then drip irrigated (N_{soil} treatment). In other words, nitrogen rate N_3 for tomato and cucumber, but nitrogen rate N_2 was superior in yields.

When two-year average % N and % Ndff (nitrogen derived from fertilizer) values obtained at harvest for different soil depths under different vegetables were evaluated, higher % N and % Ndff values were obtained as the N rate increased regardless of soil depth. Generally, lower % Ndff values are obtained as the soil depth increased and as it can be seen from the table no labeled N was detected in the soil samples taken from 60-80 cm depth. The % Ndff values

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.

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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