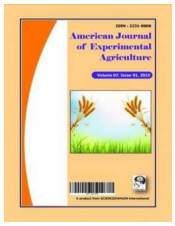

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The Effect of Different Nitrogen Dosages on Some Yield and Quality Properties of the Cucumber Grown with in Nutrient Film Technique

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

Aim: The effect of 4 different nitrogen dosages (7, 10, 13 & 16 mM) on the Plant Height, Dry Matter Yield, Number of Fruit per Plant, Fruit Yield per Plant, and Total Nitrogen Concentration of the Spring S1, which is one of the parthenocarpic hybrid cucumber types grown in Nutrient Film Technique (NFT), has been examined in this study.
Study Design: Four different nitrogen dosages (N_7, N_{10}, N_{13} and N_{16} mM) were prepared according to the Randomized Block Design with 3 replications. In evaluating the study results, the Minitab 14 statistical package program was used, and the variance analysis Fig was prepared thus making it possible to determine the significance level of the subjects. According to the $p<0.05$ probability value, the Low Significant Difference Values(LSD) were determined,
Place and Duration of Study: This research, Uludag University Vocational School of Technical Sciences, Parks and Horticulture Application was carried out in greenhouses
Methodology: The plants were germinated in egg-trays, and after they had 3 leaves they were transferred to NFT Units with 12 compartments in which 16 plants were grown and which had the size of 105 cm x 91 cm x 47 cm with 4 pieces of 155 mm x 70 mm growth channel. The Plant Height, Dry Matter Yield (root, body and leaves), Fruit Yield, and Total Nitrogen Amount (root, body

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and leaves) were analyzed in the study. Plant Height, Dry matter yield and total nitrogen content the plant samples were taken out (collected) with their roots on the 21st, 42nd, and 63rd days after planting. Number of fruit per plant and Fruit yield per plant the plant samples were taken out with their roots on the 42nd, 52nd, 63rd days after planting.

Results: According to the results obtained in the study, the values of the examined characteristics increased until the N_{13} dosage of the nitrogen; and started to decrease in the N_{16} dosage, which is the next dosage. While the effect of the nitrogen dosages on the nitrogen concentrations in the roots was not considered as being statistically significant, it was considered as being significant in the stem and leaves.

Conclusion: Generally, it may be suggested that especially the N_{16} dosage affects the plant negatively in the examined characteristics, and that it almost starts hazardous effect in this dosage.

Keywords: Cucumis sativus; soilless agriculture; NFT; cucumber.

1. INTRODUCTION

Hydroponics is preferred in order to prevent the allelopathic relations among plants, diseases and pests stemming from the soil, to eliminate the saltiness problems which appears in the soil in the course of time, and also to eliminate the water stress and provide that the given nutrients reach the roots directly and thus obtain a quality crop with a better yield. Although the cost of this type of planting is high when compared with the other growth media (perlite, vermiculite, turf etc.), the eventual high yield compensates these costs more than expected.

The cucumber (*Cucumis sativus L*.) is a member of the *Cucurbitaceae* family in the summer vegetables group and has an economic importance. With the recent increase in diseases that are infected via soil, with better control of nutritious elements given to the plants, elimination of the side effects brought with the salinization in the soil, and the decrease in the low yield that stem from the lack of nutritious elements, the cucumber production has become widespread in soilless media (perlite, turf, vermiculite and hydroponics).

The nitrogen is a basic and unique macro element that increases the yield of the plant [1]. In the land types with continental climates, where plant development is limited, farmers use nitrogenous fertilizers and support the plant development [2]. Many plants absorb the ammonium (NH_4^+), nitrate (NO_3^-), nitrite (NO_2^-), amino acid and urea, which are soluble forms of nitrogen in the soil solution [3]. However, the type of the plant, environmental conditions, light density, soil properties, and root zone temperature affect the nitrogen absorption [4]. The nitrogen influences the plant yield and quality in a direct way [5]. When given in proper ratios, it supports especially the root growth and ensures that the plant has a healthier structure [6]. In case of nitrogen deficiency, leaves become yellow and are lost before the due time, the lifespan of flowers decrease, fruits become lighter in color, and do not grow in sufficient rate and are smaller than usual. In case of imbalanced or excessive use of fertilizers, the standard fruit size is ruined and the fruit becomes softer. In addition, the NO_3 and NO_2 forms of excessive nitrogen damages the environment [7,8], accumulates on the fruit and damages human health [9]. For this reason, in determining the fruit yield level, it is very important to optimize the plant nitrogen management in the greenhouse in order to decrease the environmental dangers. To do this, it is necessary to measure the effects of the nitrogen on the plant growth process and plant yield [10]. I would hope there would be a remedy in cases referred to the results of this research.

Although there are many studies in the literature on cucumber planting in field conditions and the use of fertilizers, there are few studies on determining the proper dosage of nitrogen that determines the yield and quality of the cucumber grown in NFT Method [9,11,12]. In one of the rare studies in the literature it was reported that the 10 kg $^{-1}$ and 20 kg $^{-1}$ dosages in controlled greenhouse conditions give the best results in terms of economic benefit, human consumption and fruit quality; and the 40 kg $^{-1}$ dosage cause low quality products and increase the NO_3^- accumulation in the fruit [13]. In another study, it was reported that the 200 mg kg^{-1} N dosage in planting cucumber in perlite affected plant development and fruit production in a positive way, and that the N dosages at and over 300 mg kg^{-1} decreased the plant development and yield [14,15]. Jarozs et al. [16] reported that the highest fruit yield was observed in the highest

nitrogen dosage. Babik and Kowalczyk [17] stated that the fruit yield decreased at 200 mg dm^{-3} application.

2. MATERIALS AND METHODS

In this study, the material Spring F_1 cucumber, which is one of the parthenocarpic hybrid type grown in the area, was used. Spring F_1 is an early-yielding type of cucumber and proper for spring and summer growth seasons with mid-green fruits and 12 cm in length. The fruits are very delicious and the shelf life is longer.

Four different nitrogen dosages (N_7, N_{10}, N_{13} and N_{16} mM) were prepared according to the Randomized Block Design with 3 replications. A separate solution was used for the nitrogen dosages, and a specific solution which was prepared for cucumber by Sonneveld and Straver (1992) was used for the other elements (Table 1). The ammonium nitrate, potassium nitrate, calcium nitrate, magnesium nitrate and mono ammonium phosphate were used as the N sources in the prepared solutions.

Table 1. The contents of the nutrient solution used in the experiment [18]

Nutrient	mM
H_2PO_4	1.0
K	6.5
Mg	1.0
Ca	2.75
SO_4	1.0
Fe µmol.l-1	15
Mn	10
B	25
Cu	0.75
Zn	5
Mo	0.5
Si	0.75

The plants were germinated in egg-trays, and after they had 3 leaves they were transferred to NFT Units with 12 compartments in which 16 plants were grown and which had the size of 105 cm x 91 cm x 47 cm with 4 pieces of 155 mm x 70 mm growth channel. The Plant Height, Dry Matter Yield (root, body and leaves), Fruit Yield, and Total Nitrogen Amount (root, body and leaves) were analyzed in the study. The plant samples were collected with their roots on the 21^{st}, 42^{nd} and 63^{rd} days after planting.

2.1 Plant Height

The height measured from the level of growth medium and expressed in cm.

2.2 Dry Matter Yield

The plant samples collected from each plot were immediately transported to laboratory in closed polyethylene bags and washed thoroughly with tap water, acidified (0.1 M HCl) water and then distilled water [19]. Then the wet weights were measured. The samples were oven-dried at 70ºC for 72 hr and finely ground in stainless steel mill to pass through a 0.5 mm sieve. Care was taken to prevent contamination at all steeps in progress. The plants that were taken out from the oven were weighed again and the total dry matter yield was reported in grams.

2.3 Number of Fruit per Plant

All the fruits on the plant were counted.

2.4 Fruit yield per Plant

All fruits which were ripe enough on the plant were collected and weighed in a sensitive scale and recorded in grams.

2.5 Total Nitrogen Content %

Total N contents in the plant samples were estimated by Kjeldahl digestion procedure [20].

In evaluating the study results, the Minitab 14 statistical package program was used, and the variance analysis Fig was prepared thus making it possible to determine the significance level of the subjects. According to the $p<0.05$ probability value, the Low Significant Difference Values(LSD) were determined, and the differences of the numbers were evaluated.

3. RESULTS AND DISCUSSION

3.1 Plant Height

The effects of different nitrogen dosages on plant height on Planting the Following Day (PFD) are given in Fig. 1.

As can be seen in Fig. 1, it is observed that the average Plant Height increased until the N_{13} dosage; however, it is also observed that the Plant Height decreased at the N_{16} dosage, which is the highest dosage. The biggest Plant Height value was measured in N_{13} x 63^{rd} PFD interaction (140.28 cm), and the smallest Plant Height value was measured in N_7 x 21^{st} PFD interaction (45.15 cm).

The order of the effects of nitrogen on Plant Height is as $N_{13}>N_{16}>N_{10}>N_7$. These findings are in accordance with the findings stating that the nitrogen dosage increases the plant height [21].

3.2 Dry Matter Yield of the Plant

The effect of different nitrogen dosages on the root, stem and leaves dry matter yield of the plant on Planting the Following Day (PFD) is shown in Fig. 2.

The root, body and leaves dry matter yield of the plant increased until the N_{13} dosage (Fig. 2). The biggest root dry matter yield was obtained in N_{13} x 42nd PFD (1.65 g.); stem dry matter yield in N_{13} x 63rd PFD (27.41 g.); and leaf dry matter yield in N_{13} x 63rd PFD (27.26 g.) interactions. Just as it is the case in Plant Height characteristics, the effect of nitrogen dosages was observed as $N_{13}>N_{16}>N_{10}>N_7$. These findings are in accordance with the findings reporting that the nitrogen dosage increases the dry matter yield of the plant [22].

3.3 Number of Fruit per Plant

When evaluated in general, an increase in the number of the fruits was observed in nitrogen dosage treatments and this increase was found to be statistically significant in terms of nitrogen dosage average values and in terms of days (Fig. 3). In these characteristics, the number of fruit increased from the lowest dosage till the N_{13} dosage; however, decreased in N_{16} which is the highest dosage. Since the doesn't appear on the 21st day, it was measurement on the 42nd, 52nd and 63rd.

The highest number of fruit was obtained from the N_{13} x 63rd PFD (20.28 pieces) interaction; and the lowest number of fruit was obtained from the N_7 x 21st PFD interaction (5.32 pieces). The order of the effect of the nitrogen on the number of fruit has been determined as $N_{13}>N_{16}>N_{10}>N_7$.

3.4 Fruit Yield

The effect of different nitrogen dosages on the fruit on Planting the Following Day (PFD) is shown in Fig. 4.

The fruit yield has increased generally as parallel to the increase in the dosage of the nitrogen (Fig. 4). The highest yield was obtained in N_{13} x 52nd PFD (3291 g. plant^{-1}) interaction; and the lowest yield was obtained in N_7 x PFD (803g. plant^{-1}) interaction. As it is the case in all nutrient elements, the reflection of the increase in the nitrogen dosage to the fruit yield has been negative after a certain level (N_{13}). These findings are parallel to the findings of some other researchers [13,23]. The order of the effects of nitrogen on Plant Fruit Yield has been as $N_{13}>N_{10}>N_7>N_{16}$.

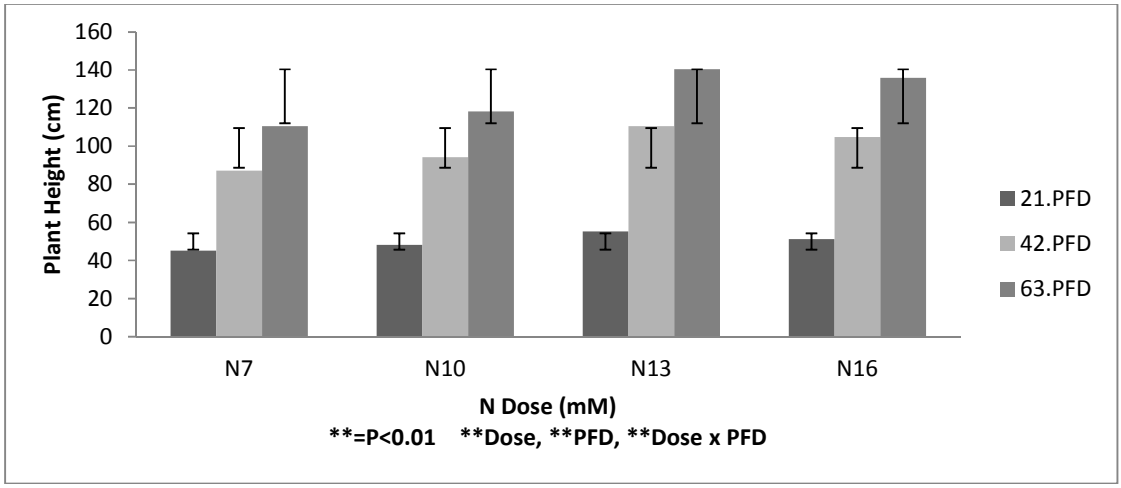

Fig. 1. The effect of different nitrogen dosages (7, 10, 13 & 16 mM) on cucumber plant height (cm) on planting the following day (21st, 42nd, 63rd days)

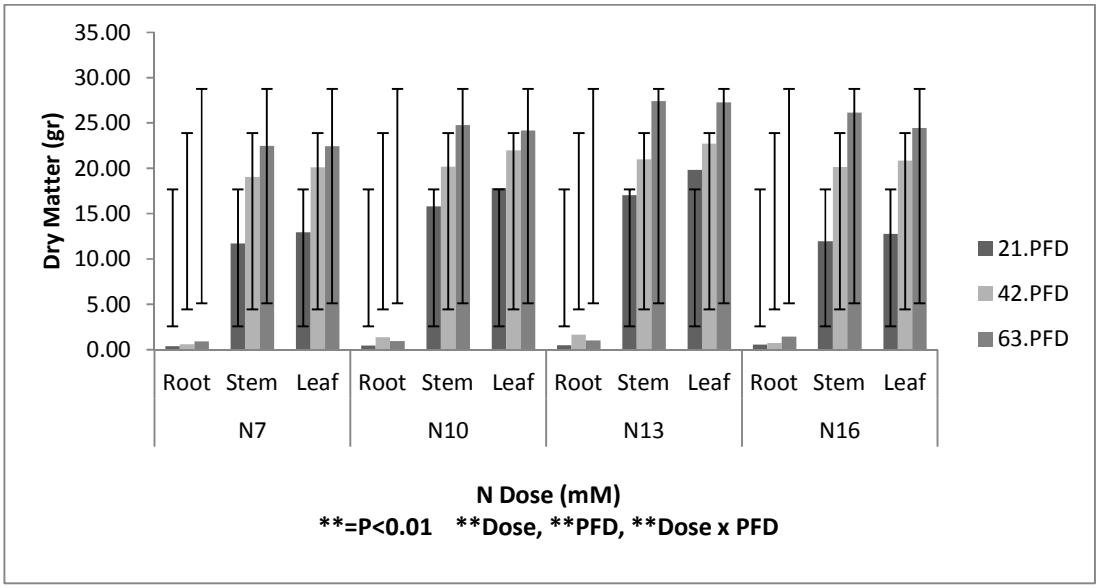

Fig. 2. The effect of different nitrogen dosages (7, 10, 13 & 16 mM) on dry matter yield of cucumber root, body and leaves on planting the following day (21st, 42nd, 63rd days)

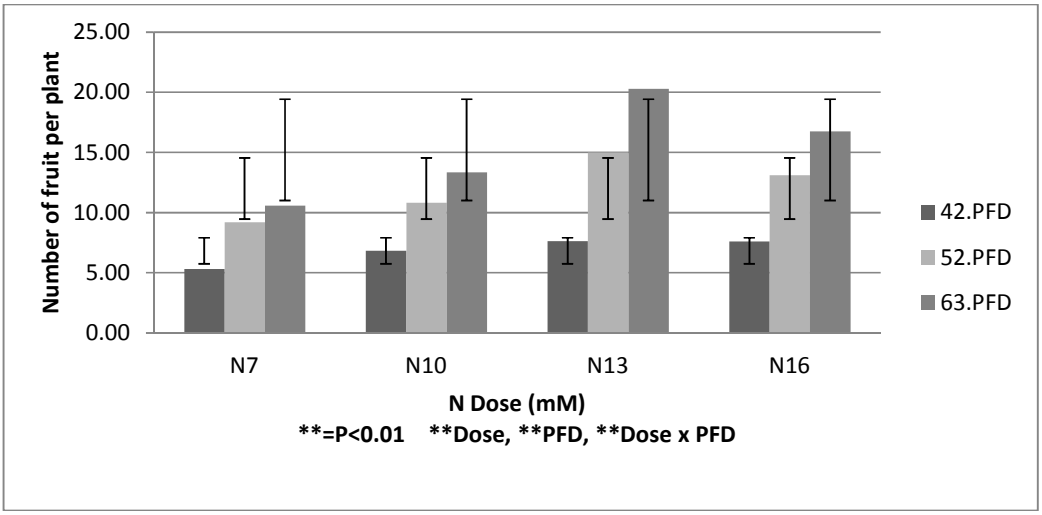

Fig. 3. The effect of different nitrogen dosages (7, 10, 13 & 16 mM) on fruit number of cucumber on planting the following day (42nd, 52nd, 63rd days)

3.5 Total Nitrogen Concentration in the Plant

The effect of different nitrogen dosages on total nitrogen concentration in different parts of the plant is given in Fig. 5.

As can be seen in Fig. 5, when each dosage is evaluated individually, the nitrogen concentration in the root decreased on the following PFDs; the nitrogen concentration in the stem increased first and then decreased; and the nitrogen concentration in the leaves increased regularly. The highest nitrogen concentration in the root was obtained in N_{13} x PFD interaction (0.60); the highest nitrogen concentration in the stem was obtained in N_{13} x 42nd PFD interaction (3.24); and the highest nitrogen concentration in the leaves was obtained in N_{13} x 63rd PFD interaction (4.20).

The order of the effects of nitrogen dosages on Plant Nitrogen Concentration has been observed as $N_{13}>N_{10}>N_7>N_{16}$.

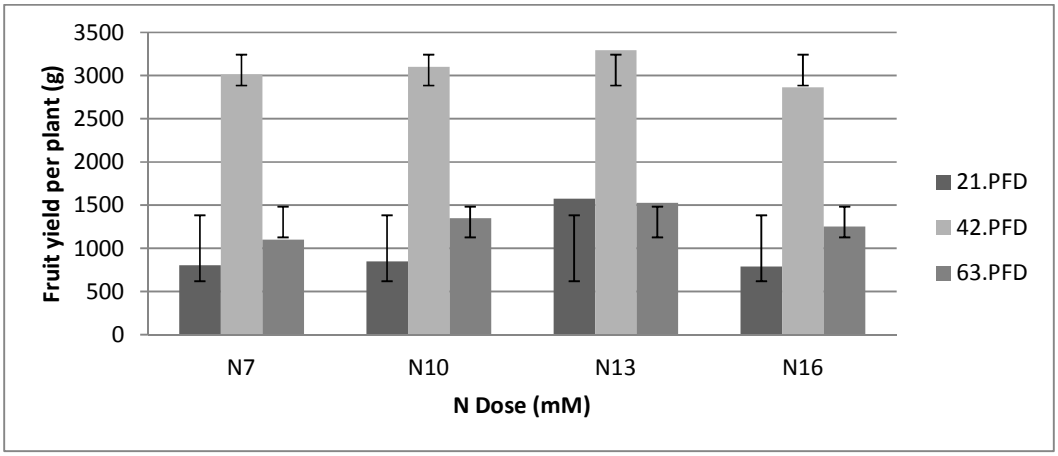

Fig. 4. The effect of different nitrogen dosages (7, 10, 13 & 16 mM) on the number of fruit per plant on planting the following day (42nd, 52nd, 63rd days)

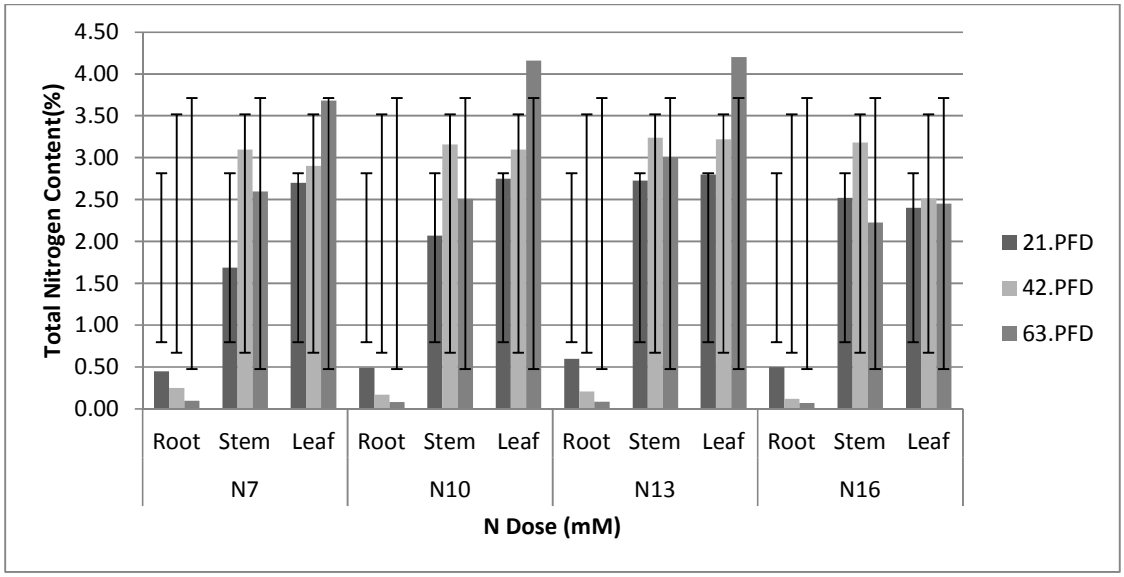

Fig. 5. The effect of different nitrogen dosages (7, 10, 13 & 16 mM) on total nitrogen concentration in different parts of the plant on planting the following day (42nd, 52nd, 63rd days)

According to the findings of the study, the values of the examined characteristics increased till the N_{13} level of the nitrogen; and then turned to decrease in the N_{16} dosage, which is the next dosage. These results are consistent with the findings of many other researchers [13,14,17,21, 22,23].

On the other hand, the N concentrations determined in the root, body and leaves of the plant showed differences when compared with the nitrogen dosage amount and sampling periods. The highest values in the same dosage were obtained on the PFD in the roots; on the 42nd PFD in the stem; and on the 63rd PFD in the leaves. This situation is considered to be related with the mobility of the nitrogen in the stem of the plant because the nitrogen is a mobile element in the plant [24].

4. CONCLUSION

Generally, it may be suggested that especially the N_{16} dosage affects the plant negatively in the examined characteristics, and that it almost starts hazardous effect in this dosage.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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