Impact of Nitrogen Levels and Planting Density on the Growth and Yield of Okra (Abelmoschus esculentus L. Moench)

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The study was carried out to the effects of different plant densities and nitrogen levels on okra yield and plant development. Field trials were conducted in two locations, the training fields of the Ege University, Ödemiş Research and Training area, and Ege University Faculty of Agriculture, Menemen Research and Training Farm. The field layout was a split-plot design with 3 replicates, where main plots consisted of nitrogen applications and sub-plots of plant densities. Fertilizer was applied in the form of Triple Superphosphate, Potassium Sulfate, Urea and Ammonium Nitrate. Five different nitrogen levels (F1: 0, F2: 40, F3: 80; F4: 120 and F5: 160 kg N ha⁻¹) and two different rows spacing (PD1: 15 cm×70 cm and PD2: 25 cm×70 cm) have been tested. Yield and yield components, plant height at flowering, height of the first fruits, the number of leaves, the number of branches, the number of days from sowing to first flowering, the number of days from sowing to first harvest, plant height, foliation status, total yield, yield of plant, average fruit weight, fruit length, fruit diameter have been noted in the field experiments. Total yield ranged from 5923.8 to 12888.9 kg ha⁻¹ at the Ödemiş location, while it was 3363.3-5009.2 kg ha⁻¹ at the Menemen location. In conclusion, the highest yield is taken from F2 in both plant densities in Ödemiş. In Menemen, the highest yield is taken from the dose of F3 (80 kg N ha⁻¹) and F4 (120 kg N ha⁻¹).

Introduction

Okra (Abelmoschus esculentus L.) is one of the most important vegetable crops grown in Turkey, with is 31428 tons (Anonymous 2019). Consumption has been increasing, due to awareness of the health benefits of okra.

Yield of okra has been sustained by intensified cultural practices including the planting density, and increased use of fertilizer, compost and synthetic chemicals. Okra productivity can be determined by cultivar and plant population (Salau and Makinde 2015). Muenoke and Asiegbu, (1996) reported decreased pod yield per plant and yield components as population increased. Maximum fruit length, fruit weight, fruit number and yield per plant of the most extensive ranges have been recorded by various researchers (Singh, 1990; Weiner, 1990; Muenoke and Asiegbu, 1996; Ali, 1999; Anjum and Amjad, 1999; Olasantan, 2001; Kabura et al., 2002; Muenoke and Asiegbu, 2003; Manga and Mohammed, 2006; Salau and Makinde, 2015; Khanal at al., 2020; Adekya at al., 2020; Regmi et al., 2020; Verma et al., 2020). Increasing plant population may result in growth and yield decrease per plant due to inter-and intraspecific plant competition. However, a higher population might compensate for plant density-induced decreased growth and yield (Salau and Makinde, 2015).

Nitrogen is the most essential element of plant nutrition. Sufficient nitrogen supply improves cell division and photosynthetic activity of the plant (Sharma and Yadav, 1996). Thus, nitrogen is often considered the most important limiting factor, for crop yields. Formation of each yield component depends strongly on the N supplied at each developmental stage throughout the life cycle of the plant (Zhang et al., 2007). However, it is important to use nitrogen fertilizer in optimum amounts. Unconsciously, the use of excessive amounts of nitrogen can cause a decrease in the quantity and quality of the product and increase input costs, it can also cause environmental pollution because N is very...
mobile in the soil and can be leaching and contaminated into groundwater (Gastal and Lemaire, 2002).

Some researchers used NPK fertilizers for the increase of growth, yield and yield attributes of okra. Significant increase in the growth and yield of okra was observed after the application of N and NPK. Nitrogen, phosphorus and potassium fertilizer applications increases vegetative growth, yield and quality characteristics (Verma et al., 1970; Singh, 1979; Hooda et al., 1980; Mani and Ramanathan, 1980; Fatokun and Chheda, 1981; Sherestha, 1983; Majanbu et al., 1985; 1986; Mishra and Pandey, 1987; Abusaleha and Shanmugavelu, 1988; Arora et al., 1991; Faraq and Damrany, 1994; Fondane and Bhatia, 1995; Haque and Jakho, 1996; Katung et al., 1996; Anjum and Amjad, 1999; Khan et al., 2000; Amjad et al., 2002; Kabura et al., 2002; Mounke and Asiegbu, 2003; Manga and Mohammed, 2006; Rahman and Akter, 2012; Khanal et al., 2020, Adeckya et al., 2020, Regmi et al., 2020, Verma et al., 2020). Also, several researchers have reported linear increase in green pod yield of okra with the application of N from 56 to 150 kg/ha (Majanbu et al., 1985; Singh, 1995; Khanal et al., 2020; Adeckya et al., 2020, Regmi et al., 2020; Verma et al., 2020). Firoz (2009) reported that the highest yield (16.73 t ha⁻¹) was obtained after the application of 100 kg N ha⁻¹ which was statistically identical to 120 kg N ha⁻¹.

This study was undertaken to evaluate the effects of different plant densities and nitrogen levels on plant development and yield in okra in two different locations.

Materials and Methods

Research Area

The study was conducted at two locations (Ege University Odemis Research and Training area-Odemis location (L1)-, and Ege University Faculty of Agriculture, Menemen Research and Training Farm -Menemen location (L2)-. Research field of altitude for L1: 136 m and 22 m for Menemen location.

Meteorological Data of Research Areas

For L1 and L2 locations, monthly averages of air temperature and total rainfall (Anonymous, 2018a; Anonymous, 2018b) are presented in Table 1. When Table 1 is examined, it is understood that a typical Mediterranean climate is dominant in the trial area in L1. October to April is rainy period. The climatic characteristic of L2 has not been a limiting factor in the cultivation of okra plant.

Establishment of Field Experiment and Applications

Field trials were conducted in two locations (L1 and L2). The field layout was a split-plot design with 3 replicates, where main plots consisted of nitrogen applications and sub-plots of plant densities. Five different nitrogen levels (F1: 0, F2: 40, F3: 80; F4: 120 and F5: 160 kg N ha⁻¹) and two different within row spacing (PD1: 15+70 cm and PD2: 25+70 cm) have been tested. In the research it was used basic fertilizer as P₂O₅ in the form of the TSP to 80 kg ha⁻¹ and 120 kg ha⁻¹ K₂O fertilizers are given in the form of K₂SO₄. Fertilizer was applied as a band. All of phosphorus, 60% potassium and 25% of nitrogen were applicable with sowing. Two of the remaining nitrogen and potassium was applied after 20 days, seedlings from the emergence. The other half was applied after 40 days. Nitrogen was applied as Urea (46%) form in plantation and the other part was applied as Ammonium Nitrate (26%).

Soil Properties of the Research Site

The soil samples were taken from 0-20 cm depth to determine soil properties of the both locations. The physical and chemical properties of the soils are shown in Table 2. Table 2 shows that the soil of L1 was neutral, had no salinity problem, was low in CaCO₃ and organic matter and had a loamy sandy texture. The total N and available K contents of the soil were low and P was rich.

In L2 experiment field soil was medium alkaline reaction. It was rich in lime, poor in organic matter and had a loamy sandy texture. Total N, available P and K amounts were low (Güneş et al., 2000; Chapman and Pratt, 1961).

Cultural Practices

Sowing

Kaymakçı okra variety was used in this the study. This variety is grown as for canned in the region. Seeds were sowed on 26 April in both locations. All cultural practices, irrigation, weed control, etc. in both locations was applied on all parcels equal. The seeds were sown into the soil by hand. Inter rows were 15 cm (PD1) and 25 cm (PD2), row distance was 70 cm.

Maintenance Procedures

In the study, during plant growth, irrigation, hoeing and weed control were made according to Vural et al. (2000); Yoldas et al. (2018). In periods in which the trial was conducted, any disease or harmful effects were observed in okra plants. Therefore, it has been done to fight against them, and weeds chemical control has not been applied to the plots. Only some dominant and large weed (Anthemis sp., Avena fatua, etc.) is rooted hands and anchor.

Harvest

To determine the yield and yield components; 250-gram samples (from large fruits) were taken from each plot. Fruits have been harvested twice a day regularly.

Soil Physical, Chemical, Analysis Methods

Soil samples (0-20 cm depth) were taken from all treatments and pH (Jackson, 1967), total soluble salt (Anonymous, 1951), CaCO₃ (Kacar, 1995), Organic matter content (Reuterberg and Kremkurs, 1951) and texture (Bouyoucos, 1962) were determined. Total N was determined according to Bremner (1965), available K was determined after extracting with 1 N NH₄OAc by flame photometer (Jackson, 1967; Atalay et al., 1986). Available P was measured by colorimeter after extracting with distilled water (Bingham 1949).

The Scope of the Research Examined the Characters

Plant height at flowering (cm), height of the first fruits (cm), the number of leaves (unit), the number of branch (unit), the number of days from sowing to first flowering (day), the number of days from sowing to first harvest (day), plant height (cm), foliation status (low, medium, good), total yield (kg ha⁻¹), yield of plant (g), average fruit weight (g), fruit length (cm), fruit diameter (cm) has been noted in the field experiments in both locations. All measurements were performed according to standard after seedling emergence.
Table 1. Monthly averages of air temperature and total rainfall of the research areas.

| Months | Odemens (L1) | Menemen (L2) |
|--------|--------------|--------------|
|        | Air temperature (°C) | Total rainfall (mm) | Air temperature (°C) | Total rainfall (mm) |
| January | 5.6          | 19.9         | 9.3          | 17.2         |
| February | 8.2          | 54.0         | 9.6          | 24.2         |
| March   | 11.0         | 15.0         | 12.6         | 38.4         |
| April   | 16.2         | 35.2         | 15.1         | 0.4          |
| May     | 20.5         | 31.7         | 21.5         | 42.8         |
| June    | 25.4         | 7.0          | 26.6         | 5.0          |
| July    | 27.9         | -            | 29.0         | -            |
| August  | 28.4         | -            | 28.0         | -            |
| September | 22.8       | 6.7          | 23.0         | -            |
| October | 17.9         | 74.5         | 18.1         | 61.0         |
| November| 10.2         | 138.5        | 11.4         | 24.2         |
| December| 6.8          | 126.2        | 8.2          | 6.0          |
| Σ (X)   | 16.7         | 508.7        | 17.7         | 219.2        |

Table 2. Some physical and chemical properties of trial soils

| Locations | pH | Total salt % | CaCO₃ % | Sand % | Mil % | Clay | Texture | O.M | Available (mg kg⁻¹) |
|-----------|----|--------------|---------|--------|-------|------|---------|-----|-------------------|
| L1        | 7.09 | < 0.03       | 0.61    | 76.04  | 20.28 | 3.68 | Loamy-sand | 0.99 | 0.06               |
| L2        | 7.88 | 0.051        | 6.58    | 50.40  | 37.28 | 12.32| Loamy-sand | 1.29 | 0.034              |

Table 3. Effect of N fertilizer rates and Planting Density on okra growth (L1)

| Treatment | PHF (cm) | HFF (cm) | NL (unit/plant) | NB (unit/plant) | NDFF (day) | HFF (day) | PHF (cm) | FS (low, medium, good) |
|-----------|---------|---------|---------------|---------------|-----------|-----------|---------|-----------------------|
| PD1F1     | 34.88   | 12.89   | 48.97bd       | 5.83          | 53.67     | 58.00     | 97.53   | Medium                |
| PD1F2     | 39.11   | 15.50   | 31.77cd       | 5.87          | 54.67     | 59.33     | 93.60   | Medium                |
| PD1F3     | 27.33   | 13.39   | 53.97ac       | 6.07          | 56.00     | 60.33     | 103.97  | Good                  |
| PD1F4     | 31.44   | 17.97   | 26.73d        | 6.97          | 55.00     | 59.33     | 100.07  | Low                   |
| PD1F5     | 32.55   | 15.22   | 41.53bd       | 5.63          | 55.33     | 59.67     | 95.27   | Medium                |
| PD2F1     | 35.89   | 15.55   | 48.30bd       | 7.87          | 55.67     | 61.00     | 90.17   | Medium                |
| PD2F2     | 34.50   | 14.94   | 46.50d        | 5.97          | 54.33     | 59.67     | 97.07   | Low                   |
| PD2F3     | 32.55   | 15.50   | 53.20ac       | 5.40          | 55.67     | 59.33     | 99.07   | Good                  |
| PD2F4     | 36.33   | 15.77   | 59.83ab       | 6.87          | 55.00     | 58.67     | 111.53  | Good                  |
| PD2F1     | 31.89   | 14.25   | 73.67a        | 6.97          | 52.67     | 58.33     | 83.93   | Good                  |
| Average   | 33.65   | 15.10   | 46.45**       | 6.34          | 54.80     | 59.37     | 98.22   | Good                  |

*= Duncan’s multiple classification test, **: P<0.01, *: P<0.05 n.s.: not significant, (Plant height at flowering (cm)-PHF-Height of the first fruits (cm)-
HFF-Number of leaves (unit/plant)-NL-The number of branch (unit/plant)-NB-The number of days from sowing to first flowering (day)-NDFF-The number of days from sowing until the first harvest (day)-NDFHM-Plant Height (cm)-PH-Foliation status (low, medium, good)-FS-)

**Data Analysis**

The findings from the trials have been analyzed separately in locations. Data were analyzed with SPSS 13.0 statistical package program are determined based on differences between the mean Duncan multivariate analyses (Efe et al., 2000).

**Results**

**L1 Location Data**

**Effect of N Fertilizer Rates and Planting Density on Okra Growth (L1)**

The data of planting density and fertilizing is given in Table 3. The effect of the combination on plant height in flowering, height of first fruits, the number of branches, the number of days from sowing to first flowering, the number of days from sowing to first harvest and plant height were statistically insignificant. The effect of applications on number of leaves was statistically significant (P<0.01).

The highest value (73.67 units) was recorded in the combination of PD2F1, when the minimum value was obtained from PD2F4 (26.50 units). The values of the number of days from sowing to first flowering were examined, PD1F3 in the first place with 56 days, while the application of PD2F1 was ranked last as the minimum value with the value 52.67 day. Compared to applications in terms of the number of days to first harvest, the values are close to each other the number of days of sowing to the first harvest has been changed 58-61 day.

**Effect of N Fertilizer Rates and Planting Density on Yield and Yield Components (L1)**

The values for yield and yield components obtained from L1 location are given in Table 4. Total yield values were found safely important (P≤0.05) in L1. The highest value has been achieved from PD1F1 (12888.9 kg ha⁻¹), lowest value has been achieved from PD2F5 (4561.9 kg ha⁻¹) and the average value is 7509.5 kg ha⁻¹.

The values obtained at L1 the difference between the averages of fruit weight applications in terms of P≤0.05 to be significant were found safely. The highest value (4.98 g) reached in PD2F2 application. In PD1F4 application, the fruit weight was determined as 3.41g.
Table 4. Effect of N fertilizer rates and Planting Density on yield and yield components (L1)

| Treatments | Total yield (kg ha⁻¹) | Yield of plant (g/plant) | Number of fruits (per plant) | Average fruit weight (g) | Average fruit length (cm) | Average fruit diameter (cm) |
|------------|------------------------|--------------------------|-----------------------------|--------------------------|--------------------------|---------------------------|
| PD1F1      | 8634.9ᵇ                | 90.67                    | 23.33                       | 3.85ᵇ                    | 4.30                     | 1.02                      |
| PD1F2      | 12888.9ᵃ              | 135.33                   | 31.17                       | 4.37ᵃ                    | 4.60                     | 1.02                      |
| PD1F3      | 8000.0ᵇ              | 84.00                    | 23.50                       | 3.53ᵇ                    | 4.74                     | 1.04                      |
| PD1F4      | 8000.0ᵇ              | 84.00                    | 24.83                       | 3.41ᶜ                    | 3.75                     | 1.03                      |
| PD1F5      | 7095.2ᵇ              | 74.50                    | 20.17                       | 3.68ᵇ                    | 5.19                     | 1.14                      |
| PD2F5      | 4561.9ᵇ              | 79.83                    | 21.00                       | 3.88ᵇ                    | 4.40                     | 1.06                      |
| PD2F4      | 6047.6ᵇ              | 105.83                   | 29.00                       | 3.69ᵇ                    | 4.64                     | 1.09                      |
| PD2F3      | 6152.4ᵇ              | 107.67                   | 26.00                       | 3.99ᵇ                    | 5.14                     | 1.11                      |
| PD2F2      | 7790.5ᵇ              | 136.33                   | 27.67                       | 4.98ᵃ                    | 4.37                     | 1.12                      |
| PD2F1      | 5923.8ᵇ              | 103.67                   | 28.83                       | 3.64ᵇ                    | 4.27                     | 1.10                      |

Average: 7509.5ᵃ | 100.18ᵇ | 25.55ᵃ | 3.90ᶜ | 4.54ᵈ | 1.07ᵃ

*x= Duncan's multiple classification test, **: P<0.01, *: P<0.05, n.s.: not significant

Table 5. Effect of N fertilizer rates and Planting Density on okra growth (L2)

| Treatments | PHF (cm) | HFF (cm) | NL (unit/plant) | NB (unit/plant) | NDFH (day) | NDFL (cm) | FS | (low, medium, good) |
|------------|----------|----------|----------------|-----------------|------------|------------|----|-------------------|
| PD1F1      | 32.47    | 7.45     | 15.20ᵃ         | 1.33            | 46.67      | 53.00      | 47.80ᵇ | medium            |
| PD1F2      | 29.87    | 8.40     | 15.13ᵇ         | 1.33            | 45.33      | 53.67ᵃ     | 47.87ᵈ | medium            |
| PD1F3      | 33.47    | 7.60     | 17.00ᵇ         | 2.11            | 44.33      | 54.00ᵃ     | 57.20ᵇ | medium            |
| PD1F4      | 37.80    | 8.00     | 22.40ᵇ         | 2.67            | 43.67      | 54.00ᵇ     | 78.53ᵇ | good              |
| PD1F5      | 34.80    | 7.47     | 22.87ᵇ         | 2.11            | 43.00      | 54.00ᵇ     | 79.53ᵇ | good              |
| PD2F5      | 36.27    | 7.47     | 23.73ᵇ         | 2.22            | 44.00      | 52.67ᵇ     | 88.33ᵇ | good              |
| PD2F4      | 28.47    | 8.73     | 21.80ᵇ         | 2.44            | 46.33      | 53.00ᵇ     | 72.47ᵇ | good              |
| PD2F3      | 33.33    | 7.60     | 19.93ᵇ         | 2.00            | 41.33      | 53.67ᵃ     | 60.60ᵇ | good              |
| PD2F2      | 32.47    | 7.00     | 15.60ᵇ         | 2.11            | 44.00      | 54.00ᵇ     | 44.73ᵈ | Medium            |
| PD2F1      | 26.60    | 7.67     | 11.60ᵇ         | 1.89            | 46.00      | 53.00ᵇ     | 41.27ᵃ | Medium            |

Average: 32.55ᵃ | 7.74ᵃ | 18.53ᵇ | 2.02ᵇ | 44.47ᵃ | 53.50ᵇ | 61.83ᵃ

*x= Duncan's multiple classification test, **: P<0.01 important, *: P<0.05 important, n.s.: no significant, (Plant height at flowering (cm)-PHF-Height of the first fruits (cm)-HFF-Number of leaves (unit/plant)-NL-The number of branch (unit/plant)-NB-The number of days from sowing to first flowering (day)-NDFH-The number of days from sowing until the first harvest (day)-NDFL-Plant Height (cm)-PH-Foliation status (low, medium, good)-FS-

Table 6. Effect of N fertilizer rates and Planting Density on okra growth (L2)

| Treatments | Total yield (kg ha⁻¹) | Yield of plant (g/plant) | Number of fruit (per plant) | Average fruit weight (g) | Average fruit length (cm) | Average fruit diameter (cm) |
|------------|------------------------|--------------------------|-----------------------------|--------------------------|--------------------------|---------------------------|
| PD1F1      | 3642.6                 | 52.23                    | 13.67                       | 4.08                     | 4.67                     | 1.31                      |
| PD1F2      | 3897.8                 | 84.41                    | 13.41                       | 3.55                     | 4.15                     | 1.38                      |
| PD1F3      | 4038.3                 | 46.03                    | 12.46                       | 4.86                     | 4.47                     | 1.42                      |
| PD1F4      | 5009.2                 | 55.65                    | 16.40                       | 4.73                     | 4.97                     | 1.56                      |
| PD1F5      | 4983.3                 | 64.51                    | 17.74                       | 4.25                     | 4.92                     | 1.42                      |
| PD2F5      | 4917.1                 | 90.66                    | 23.83                       | 5.04                     | 5.11                     | 1.47                      |
| PD2F4      | 4620.0                 | 108.76                   | 24.30                       | 4.47                     | 5.59                     | 1.45                      |
| PD2F3      | 4431.0                 | 78.84                    | 20.38                       | 5.27                     | 5.10                     | 1.50                      |
| PD2F2      | 3363.3                 | 81.04                    | 16.93                       | 4.10                     | 5.09                     | 1.39                      |
| PD2F1      | 3748.3                 | 111.99                   | 18.83                       | 3.18                     | 3.60                     | 1.24                      |

Average: 4265.1ᵃ | 77.41ᵇ | 4.35ᵃ | 1.41ᵇ

*x= Duncan's multiple classification test, **: P<0.01 important, *: P<0.05 important, ns: no significant

L2 Location Data

Effect of N Fertilizer Rates and Planting Density on Okra Growth (L2)

The values of L2 are given in Table 5. Plant height at flowering, the height of first fruits, the number of branches, the number of days from sowing to first flowering of the combination of the application were found to be statistically insignificant effect.

The effect of the combinations of application on number of leaves, the number of days of sowing until the first harvest and final plant height was statistically significant (P<0.01). The effect of the application in terms of the number of days to first harvest was statistically significant (P<0.01). The values are close to each other and the number of days to first harvest day has been changed between 52.67 and 54.00 days.

Effect of N Fertilizer Rates and Planting Density on Yield and Yield Components (L2)

In L2 location, the values for yield and yield components are given in Table 6. As shown in Table 6, the effect of application on yield and yield components were found to be statistically insignificant. Menemen location in terms of total yield values obtained when examining applications, the highest value has been reached from PD1F4 (5009.2 kg ha⁻¹).

The location average has been determined as 4265.1 kg ha⁻¹. The resulting yield per plant was not a significant difference in terms of the statistics. The value of the highest
yield per plant is reached in PD2F1 (111.99 g) when the minimum value was recorded from the application PD1F3 (46.03 g). In terms of the average fruit size there was no significant difference in statistical terms.

**Discussion, Conclusions and Recommendations**

The effect of fertilizer and planting density application were not found to be statistically significant on the number of days until first flowering in both locations. Birbal et al. (1995) and Ali, (1999) reported that plant density did not have any impact on the number of days of flowering. For this reason, the results of the study are consistent with previous studies (Ali, 1999; Birbal et al., 1995; Amjad, 2002). The number of flowerings until the first day as the control plot in determining 53.07 days, this value is recorded in other applications in the range of 51.07 to 55.93 days (Khan et al., 2000). These values correlated with the values obtained in our study. The highest yield was obtained in the dense spacing. In both planting density applications in general it can be said that the increased value of high fertilizer dose of fruit size. However, the effect of planting density on fruit size has been determined and the maximum value has been obtained the largest planting density (PD2). These results are in concordance with the results presented by. Singh (1990) have reported the most sowing distances, reaching maximum fruit length. Number of pods per plant was affected by cultivar, planting density, year, and the cultivar by year interaction. Pod yield per plant was affected by planting density, year, and the cultivar by year interaction (Salau and Makinde, 2015). The number of fruits per plant increased with increasing planting density which found by Amjad et al. (2002); Salau and Makinde (2015) is parallel to our results. Olasantan (1999) reported that, different nitrogen rates (0, 60, 120 kg/ha) increase the number of fruits per plant in okra. It is observed that the number of these values obtained in our study is lower. Singh (1990); Birbal et al. (1995); Ali (1999) stated that more heavy fruits as the distance increases between the plants have occurred. The effect of applications on the total yield for L1 was found to be significant (P≤5%). Total yield and yield per plant depends on plant density. For this reason, high efficiency is being imported in often sowing (because of the presence of more plants) and wide range of sowing, the yield decreases. The increase in yield per hectare due to increased planting density indicated that increased population made up for reduced yield per plant. Maximum yield of okra due to increased densities has been reported with other cultivars in a different environment (Pandey and Sing, 1979; Sarmaik et al., 1986; Khan and Jaisal, 1998; Salau and Makinde, 2015). The highest total yield is obtained by often sowing has been identified by some researchers (Amjad et al., 2002; Singh, 1990; Ali, 1999). Expanding plant distance, the plant takes to more nutrients and minor development increases, and consequently also an increase in the number of fruits per plant for each plant has been observed. Excessive N rates in the yield fruit is fall, probably, depend on the number of fruits per plant. There were problems in production of okra when the rate of nitrogen excessive and above on 120 kg ha\(^{-1}\) and the yield was decrease. It is connected to the reduced number of fruits per plant. As a result, the necessity of fertilization in okra cultivation in ecological conditions of the region, considering the positive effects on soil productivity, F3 (80 kg ha\(^{-1}\)) and F4 (120 kg ha\(^{-1}\)) of fertilizer may indicate that the dosage is appropriate. The highest yield is taken from F2 in both plant densities in L1. In L2, the highest yield is taken from the dose of F3 (80 kg N ha\(^{-1}\)) and F4 (120 kg N ha\(^{-1}\)). The reason for this, the soils of the experimental field in L1 is N contain a total of approximately 2 times according to L2.

Okra is an important vegetable in the Aegean region as the proposed frequency and fertilizer doses at these locations as friendly to the environment and human health will continue to provide profit to the farmer.

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