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# THE EFFECTS OF DIFFERENT IRRIGATION METHODS AND NITROGEN FORMS WITH VARIOUS AMOUNTS ON THE YIELD AND SOME QUALITY PARAMETERS OF WATERMELON

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***Abstract***

*The research was carried out at Research and Production Farm of Agricultural Faculty, Cukurova University during 1996 and 1997 growing season. In this experiment, different irrigation methods (S: Sprinkler; D: Drip), nitrogen forms (L: Liquid; G: Granule) with various amounts (based on applied line source sprinkler irrigation method, $N_1$; $N_2$; $N_3$ kg/da) and two varieties of watermelon (P: Paladin; M: Madera) were studied. Free water surface evaporation was used to determine irrigation water amount. In only SL and SGL treatments, three different nitrogen levels were formed providing gradient situation during the irrigation season.*

*Based on the results, irrigation water ranged from 119.2 mm (first year) to 350.5 mm (second year). Nitrogen applications varied from 5.1 kg $da^{-1}$ (SL) to 10 kg $da^{-1}$ (SG) in the all treatments. Total yield changed between 1325 kg $da^{-1}$ (first year) and 5013 kg $da^{-1}$ (second year) depending on year and treatments. Although, the highest yield was taken from treatments in which liquid fertilizers were applied for both of the varieties in the first year. The varieties have different response to form and amounts of nitrogen in the second year. In this year, the highest yield was obtained from SG treatment in Paladin variety. The yield decreased only by 12% in SL treatments that nitrogen was applied in liquid form. In Madera variety, the highest yield was taken from SGL treatments that granule and liquid fertilizer were applied together.*

*The effects of irrigation methods and nitrogen levels on some quality parameters of watermelon were found to be insignificant (P>0.05). However, fruit diameter of Madera was larger than Paladin variety. The longest fruit length was measured in Paladin-DL treatment.*

*As a result, it was determined that watermelon yield was increased by nitrogen which was applied through irrigation water. Therefore, it could be said that watermelon yield increased considerably with applying nitrogen together with irrigation water in each irrigation application.*

***Key words**: Drip irrigation, nitrogen, sprinkler irrigation, watermelon.*

## INTRODUCTION

Watermelon production is being taken very important place in the world agriculture for vegetable yield. There are production capacity about 109.3 million tones and 3.5 million ha planting area in the world. Turkey is the second largest watermelon producer after China in the world and the first in Europe because of 3.9 million tone yield and 157585 ha planting area (FAOSTAT, 2015).

Watermelon became an important summer plant in Turkey because of its marketability and the high demand. In the last decade, watermelon growth in both under plastic cover and field conditions increased because it can be easily grown everywhere and it has high-income rate per unit area.

Adequate irrigation water supply is of vital importance to reach high yield level because of high growth rate and short growing period (Desai and Patil, 1984). But, since the watermelon is planted in the rows quite apart from each other, a part of the irrigation water gets lost in the early growth stages if water is applied by traditional surface irrigation systems. On the other hand, watermelon plant is grown crawling on the soil surface. Use of traditional surface irrigation methods in the late growing season result in development of some fungal diseases, branch and leaf decay and physical suffer from irrigation workers, consequently large yield losses may occur (Srinivas et al., 1989a).

Some problems are also faced in the growing season related to application of plant nutrients because of growth manner of watermelon. Many problems, which could be very difficult overcome, are faced in the process of mixing fertilizer to the soil besides physical damage of plants during the applications.

Problems related to both irrigation and fertilization can be solved using pressurized irrigation systems such as drip and mini-sprinkler can provide frequent irrigation and apply plant nutrients through the irrigation system. Recently, watermelon producers already have started to widely use drip and sprinkler systems together with liquid fertilizer. Giving fertilizers with water is an approach which is defined as "*fertigation*". The techniques look quite hopeful to use for plants such as watermelon which have a lot of problem with irrigation and fertilization. However, some problems may occur when these systems are not properly designed and managed.

The aim of this study was to determine the effects of different irrigation methods and nitrogen forms with various amounts on the yield and some quality parameters of watermelon

**MATERIALS AND METHODS**

The experiment was carried out at the Farm of Agriculture Faculty, University of Cukurova, during 1996 and 1997 growing season. Soil in the test area had flat level topography. Soil profile was deep and soil consists of clay in high rate. Lime content of soil was rich. Its color was dark reddish brown (Ozbek et al., 1974).

Mediterranean climate is prevailing in Cukurova Region with hot and dry summer and rainy and warm winter. The annual rainfall is about 646.8 mm that has not uniform distribution. According to long-term observation, average relative humidity, average wind speed and temperature are 66%, 2.0 $ms^{-1}$ and 18.9 $^oC$, respectively.

In this experiment, two different watermelon varieties (*P*: Paladin, *M*: Madera) were used. Paladin has the ellipse form, sweet taste and dark green color of peel. Fleshy part of the vegetable's color is dark red (Sapeksa, 1995). Variety of Madera has circular form, very sweet taste and light green color of peel. Fleshy part of the vegetable's color is also dark red (May, 1995).

Two irrigation methods, mainly sprinkler (*S*) and Drip (*D*) were employed in the experiment. The system, which is the line source sprinkler irrigation technique, was used for obtaining different water and nitrogen levels. Planning and management of the system was made using the methods and principles given by Hanks et al. (1976), and Kanber et al. (1994). For this aim, 30 m length lateral pipes were place on the plots. Full or half-turning sprinkler heads were placed with 6 m distance along the lateral line. Lateral distances were 12 m. Collecting cups were placed with 2 m distance between two laterals beginning 2 m from first line. In this way three irrigation levels were created which varied from $I_1$ that is near the line in which plants received much water to $I_3$ that is the far from line in which plants have less water. In the same condition, different nitrogen levels were obtained which varied from the most, $N_1$, to the least, $N_3$. Drip irrigation method was used in the second year of the experiment. Drip system used in the study was consists of control unit and pipe network. In-line drippers were placed with 50 cm distance along the laterals (*q*: 4 l $h^{-1}$ at 2 atm pressure). Laterals were 30 m length. Drip irrigation plots contain 3 watermelon rows and one lateral employs each row (Figure 1.). Water amount collected in the cups having known volume was measured and their nitrogen contents were analyzed. Irrigation water was provided from Lower Seyhan Irrigation Project system. Irrigation water is classified as $C_2S_1$ quality for irrigation (USSLS, 1954).

Additionally, different nitrogen forms (*G*: Granule; *L*: Liquid), application types and levels ($N_1$; $N_2$ and $N_3$ kg $ha^{-1}$) were tested. Granule nitrogen (*G*) was provided from a granule nitrogen source (21%, ammonium-sulfate). In this treatment, 1/3 part of total nitrogen was given before sowing. Remaining 2/3 of total nitrogen was applied two times. One of them (1/3 *N*) was applied in branching period and the rest of 1/3 *N* was mixed with soil by hand as base fertilizer when the first fruits have 3-4 cm diameter (Zuang, 1982). In this treatment, 10 kg $da^{-1}$ pure nitrogen was applied to the plots. In this treatment, there were no different nitrogen and water levels.

During the first year, equal water and nitrogen level were applied to the each point of plots. In the second year, gradient water level was created with line source sprinkler irrigation technique. Liquid nitrogen (*L*) was taken from liquid source which was *UAN* (Nitrogen of Urea and Ammonium Nitrate) fertilizer (32-0-0). Mentioned nitrogen coming from *UAN* was dissolved in a fertilizer tanks placed in the control unit of sprinkler and drip systems and then injected through irrigation water. Total nitrogen amounts to be given were divided to irrigation number to determine necessary nitrogen amount for each irrigation event. At the end of irrigation events, water samples were taken from collecting cups during irrigation were analyzed for obtaining actual amount of nitrogen applied to the each plot. In the plots fertilized with granule and liquid nitrogen (*GL*); 3 kg per decare nitrogen as pure matter, which were provided from granule *N* source, was given by hand before planting. Remaining part of total pure nitrogen was taken from liquid source.

The treatments were arranged on the field by the strip plot design in the first year; and split-strip plot design in the second year with three replications. Totally, there were 360 watermelon plants (180 plants for each variety) in sprinkler plots and 180 watermelon plants (90 plants for each variety) in drip plots. The seeds were sown in the torf blocks with 5x5x7 cm in dimension. Then, when seedlings reached to a sufficient size, they were transplanted the experimental area. Seedlings were planted with a row spacing of 2 m and plant spacing of 0.5 m. Phosphorus ($P_2O_5$) and potassium ($K_2O$) of 10 kg da$^{-1}$ were applied by hand to the all plots. Watermelon was harvested when atriums which were bounded to fruit stem dried, color of peel reached to maturity color and stems became thin (Gunduz and Kara, 1996). Generally, 0.5 m from each two sides of sprinkler heads were discarded; then, remaining parts were harvested (4-11 July for both experimental years).

Irrigation events were started at branching stage. Irrigation water was calculated using cumulative evaporation (*Ep*) from Class A pan values measured between consecutive irrigation (Equation 1 and 2) (Goldberg et al., 1976; Doorenbos and Pruitt, 1979).

$$I = K_{cp} \times E_p \times P \quad (1)$$

$$V_L = I \times A \quad (2)$$

where: $I$ and $V_L$ irrigation water, mm, and $L$; $K_{cp}$, plant-pan coefficient (this value considered as 1); $A$, plot area, m$^2$; $P$, wetting percent (for drip irrigation, it was 0.7) (Papazafiriou, 1980).

Determination of fruit quality was performed on fruit samples taken from each plot at harvesting. In the analyses, 3-5 fruit samples from each plot were used. Average fruit weight, length and diameter, and total solublesolids were determined on fruit samples (Alavoine et al., 1988). In the study, the effect of examined variables on the yield and quality parameters were analyzed statistically using variance analyses after average yield obtained from each plot was evaluated. Strip and split-strip plot designs were used to analyse the other parameters (Yurtsever, 1984).

## RESULTS AND DISCUSSIONS

*Irrigation applications*

First year, five irrigations were done in the growing season. First two applications were considered as the pre-plant irrigations. Generally, plants were irrigated 9-12 day intervals. Maximum irrigation water amount was applied in the middle of June. Second year of the study, seven irrigations were performed. Pre-plant irrigations were given in first three applications. Irrigations were applied generally 5-15 day intervals (Table 1).

*Applied nitrogen amount*

Nitrogen amounts from different nitrogen sources applied to watermelon through sprinkler and drip methods were shown in Table 2. Nitrogen amounts varied depending on applied irrigation water amount and irrigation method except granule nitrogen applications. The maximum nitrogen of 10 kg da$^{-1}$ was applied in *SG* treatment. Similar relationships were obtained between this study and other studies (Gunduz and Kara, 1996; Cetin and Nacar, 1997). The minimum nitrogen amount of average 5.1 kg da$^{-1}$ was applied to *SL* treatment. Nitrogen saving was about 50% in SL; 20% in *SGL* treatment as compared to *SG*.

Table 1. Total water amount applied to the treatments (mm)

| Irr No | Irr. Date | Treatments | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SG | | | SGL | | | SL | | | |
| | | SG1 | SG2 | SG3 | SGL1 | SGL2 | SGL3 | SL1 | SL2 | SL3 | D* |
| 1 | 1997 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 | 22.8 |
| 2 | | 50.2 | 50.2 | 50.2 | 50.2 | 50.2 | 50.2 | 50.2 | 50.2 | 50.2 | 50.2 |
| 3 | | 58.4 | 58.4 | 58.4 | 58.4 | 58.4 | 58.4 | 58.4 | 58.4 | 58.4 | 53.8 |
| 4 | | 68.3 | 57.0 | 47.8 | 75.7 | 68.6 | 66.4 | 68.3 | 62.1 | 57.3 | 46.5 |
| 5 | | 22.7 | 16.9 | 12.8 | 31.3 | 22.9 | 12.4 | 35.5 | 24.9 | 13.8 | 9.6 |
| 6 | | 65.0 | 40.3 | 29.2 | 62.2 | 40.3 | 33.2 | 67.9 | 40.3 | 25.2 | 37.7 |
| 7 | | 46.8 | 27.9 | 24.8 | 46.2 | 34.1 | 27.0 | 47.4 | 21.8 | 20.6 | 31.2 |
| **TOTAL** | | **334.2** | **273.5** | **246.0** | **346.8** | **297.3** | **270.4** | **350.5** | **280.5** | **248.3** | **251.7** |
| 1 | 1996 | 15.0 | | | 15.0 | | | 15.0 | 15.0 | 15.0 | |
| 2 | | 43.7 | | | 43.7 | | | 43.7 | 43.7 | 43.7 | |
| 3 | | 41.4 | | | 48.0 | | | 49.8 | 29.2 | 28.3 | |
| 4 | | 43.3 | | | 35.1 | | | 35.0 | 24.8 | 21.0 | |
| 5 | | 31.5 | | | 28.8 | | | 21.4 | 13.9 | 11.2 | |
| **TOTAL** | | **174.9** | | | **170.6** | | | **164.9** | **126.6** | **119.2** | |

* Same nitrogen amounts were applied to all treatments with drip method.

Table 2. Applied total nitrogen amount in the treatments (kg $da^{-1}$)

| Treatments | 1996 | | | | 1997 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 3. irr. | 4. irr | 5.irr. | Total | 4.irr. | 5. irr. | 6. irr. | 7.irr | **Total** |
| SG1 | | | | 10.0 | | | | | 10.0 |
| SG2 | | | | | | | | | 10.0 |
| SG3 | | | | | | | | | 10.0 |
| SGL1* | 1.9 | 0.9 | 1.7 | 7.3 | 2.6 | 0.6 | 1.9 | 0.6 | 8.7 |
| SGL2 | | | | | 2.4 | 0.5 | 1.3 | 0.5 | 7.7 |
| SGL3 | | | | | 2.3 | 0.3 | 1.0 | 0.3 | 6.9 |
| SL1 | 2.2 | 0.8 | 1.3 | 4.3 | 2.3 | 0.6 | 2.2 | 0.8 | 5.9 |
| SL2 | 1.4 | 0.6 | 0.9 | 2.9 | 2.1 | 0.4 | 1.6 | 0.5 | 4.6 |
| SL3 | 1.4 | 0.5 | 0.7 | 2.6 | 2.0 | 0.3 | 0.9 | 0.4 | 3.6 |
| DG | | | | | | | | | 10.0 |
| DGL* | | | | | 2.5 | 0.3 | 2.0 | 0.9 | 8.7 |
| DL | | | | | 2.5 | 0.3 | 2.0 | 0.9 | 5.7 |

*Granule nitrogen of 3 kg $da^{-1}$ given during transplanting was added to total amount

*Yield results*

Average total yields were shown in Table 3. Significant differences were observed in total yield between the years. In the second year, the yield increased by 70%. This could be resulted from the changes in climate, plant growth and particularly, cultural practices between the years. The maximum yields were obtained from Madera variety for both years. The effect of nitrogen forms and amounts on the yield was found to be different under *S* irrigation applications. In the first year of experiment, maximum yields were obtained from *L* treatments. In *P* variety, yield was decreased by 21% in the *G* treatments, as compared to the *L* treatments. Corresponding decrease was by 25% in *M* variety. The responses of varieties to nitrogen forms and amounts were different in the second year. Maximum yield was observed in *SG* treatment in *P* variety. The yield decreased only by 12% in *SL* treatment in which liquid nitrogen was applied 50% less than granule nitrogen. Maximum yield for *M* variety was obtained from *G* and *L* fertilizer treatments (*SGL* and *SL*). Similar results were obtained in *D* irrigation. In *P* variety, the yield reduced by 11-13% using other nitrogen forms rather than *G* fertilizer. In *M* variety, the yield decreased by 5% with *G* fertilizer applications. It can be seen that marketable yield was similar to total yield amounts (Table 4). Marketable yield varied similarly with changing total yield. It was recorded that the higher total yield gave the higher marketable yield. Maximum yield, generally, was obtained either from applications of completely *L* or *GL* nitrogen form.

Table 3. The Average Total Yield Amounts of the Treatments (kg $da^{-1}$)

| Treatments | 1996 | | | | 1997 | | | |
|---|---|---|---|---|---|---|---|---|
| | P | % | M | % | P | % | M | % |
| SG1 | 1928 | 79 | 2003 | 75 | 4352 | 90 | 4981 | 99 |
| SG2 | | | | | 4832 | 100 | 4466 | 89 |
| SG3 | | | | | 4566 | 94 | 4386 | 87 |
| SGL1 | 2233 | 92 | 2682 | 100 | 3280 | 68 | 4214 | 84 |
| SGL2 | | | | | 3485 | 72 | 4549 | 91 |
| SGL3 | | | | | 3108 | 64 | 4199 | 84 |
| SL1 | 2429 | 100 | 2529 | 94 | 3567 | 74 | 3485 | 69 |
| SL2 | 1630 | 67 | 2530 | 94 | 4236 | 88 | 4832 | 96 |
| SL3 | 1325 | 54 | 1811 | 67 | 3611 | 75 | 5013 | 100 |
| DG | | | | | 3840 | 77 | 3737 | 74 |
| DGL | | | | | 3421 | 71 | 3822 | 76 |
| DL | | | | | 3343 | 69 | 3934 | 78 |

Table 4. The Average Marketable Yield Amounts of the Treatments (kg $da^{-1}$)

| Treatments | 1996 | | | | 1997 | | | |
|---|---|---|---|---|---|---|---|---|
| | P | % | M | % | P | % | M | % |
| SG1 | 869 | 62 | 1244 | 76 | 3475 | 86 | 4160 | 100 |
| SG2 | | | | | 4056 | 100 | 3953 | 95 |
| SG3 | | | | | 3724 | 92 | 3876 | 93 |
| SGL1 | 1205 | 86 | 1633 | 100 | 2528 | 62 | 3384 | 81 |
| SGL2 | | | | | 2884 | 71 | 3815 | 92 |
| SGL3 | | | | | 2341 | 58 | 3339 | 80 |
| SL1 | 1401 | 100 | 1622 | 99 | 3040 | 75 | 2754 | 66 |
| SL2 | 551 | 39 | 1465 | 90 | 3505 | 86 | 3972 | 95 |
| SL3 | 425 | 30 | 806 | 49 | 2546 | 63 | 4090 | 98 |
| DG | | | | | 3018 | 74 | 2897 | 70 |
| DGL | | | | | 2801 | 69 | 3174 | 76 |
| DL | | | | | 2796 | 69 | 3253 | 78 |

Total and marketable yield amounts obtained from plots in both years were evaluated using variance analyses. The results were shown in Table 5. Based on results there were no significant differences between the varieties for total and marketable yield in the first year of experiment. The statistically impact of nitrogen applications on watermelon yields was investigated using orthogonal method. For this reason, total yields of nitrogen application were split by orthogonal method to the smallest influences. As a result, *SL* and *SGL* treatments were placed in the best class while *SG* took second yield class with 95% confidence. There was no statistically significant difference between varieties and nitrogen levels according to results of second year. Significant difference was determined between the irrigation methods for total yield ($p<0.05$), whereas for marketable yield both between the irrigation methods and their interaction with variety were significantly different ($p<0.05$). For total yield, average values were compared using Duncan test. Duncan test results indicated that greater yield was obtained from *S* method ($S\bar{x} = 1965$) as compared to *D* irrigation method at 5% significance level (Table 6). In the same way, averages of marketable yield values related to irrigation method-variety interaction ($S\bar{x} = 680$ and $S\bar{x} = 1360$) were compared to each other. Therefore, *S* irrigation method constituted first yield class while *D* irrigation method constituted second yield class in *M* variety; *S* and *D* irrigation methods constituted third yield group in *P* variety. These results agreed with findings of Cetin and Nacar (1997) and Stanley and Maynard (1990). From the results, it can be concluded that watermelon yield could be increased by *L* fertilizer. Although the amount of *L* nitrogen was applied less than *G* nitrogen form by 20-50%, no significant difference was observed between yields obtained from L and G nitrogen. First year data indicated that the yield was increased by 5% with *L* fertilizer. On the other hand, application of *G* nitrogen at planting/sowing did not influence the watermelon yield, since *SL* and *SGL* treatments always took statistically same yield class. On the other hand, yields were increased at 5% level by *S* system as compared to *D*; but, this factor depended on the varieties; for example, significant differences were not observed between irrigation methods in *P* variety. For this reason, reactions of varieties to irrigation methods were different. Therefore, irrigation methods to be used should be taken into consideration in selection of watermelon variety to be grown. In addition, it can be concluded that there was no significant difference between varieties. Some differences are occurred by randomly.

Table 5. Variance Analysis of Watermelon Yield

| Year | Variation Source | DF | Total Yield | | Marketable Yield | |
|---|---|---|---|---|---|---|
| | | | Mean Square | F values | Mean Square | F values |
| 1996 | Replication | 2 | 183836 | | 40476.3 | |
| | Variety | 1 | 192235$^{ns}$ | 1.12 | 515586 | 2.4 |
| | Error(1) | 2 | 171445 | | 214505 | |
| | N | 2 | 506941 | 6.45 | 349949 | 1.29 |
| | SG with Others | 1 | 1010092* | 12.85 | | |
| | SGL with SL | 1 | 14225.7$^{ns}$ | | | |
| | Error(2) | 4 | 78575.9 | | 270399 | |
| | Variety-Nitrogen Int. | 2 | 64276.7 | 0.25 | 16614.3 | <1 |
| | Error (3) | 4 | 253645 | | 100278 | |
| | General | 17 | 198477 | | 190670 | |
| 1997 | Replication | 2 | 80752.2 | | 128576.4 | |
| | Variety | 1 | 2565336$^{ns}$ | 1.61 | 2898506$^{ns}$ | 1.34 |
| | Error(1) | 2 | 1596666 | | 2155647 | |
| | Irrigation | 1 | 1945989* | 16.8 | 977791.4* | 11.74 |
| | Irrigation-Variety Int. | 1 | 461326.8 | 3.98 | 987042.3* | 11.85 |
| | Error(2) | 4 | 115843.7 | | 83269.1 | |
| | N | 2 | 767715.5 $^{ns}$ | 2.13 | 651673.5$^{ns}$ | 1.15 |
| | Error(3) | 4 | 360761.5 | | 567588 | |
| | N-Variety Int. | 2 | 1072831$^{ns}$ | 4.75 | 758840.1$^{ns}$ | 4.29 |
| | Error(4) | 4 | 225819.4 | | 177038.3 | |
| | N-Irrigation Int | 2 | 418641.8$^{ns}$ | <1 | 737460.2$^{ns}$ | 0.45 |
| | Variety-N-Irrigation Int. | 2 | 196866.1$^{ns}$ | <1 | 776754.6$^{ns}$ | 0.48 |
| | Error(5) | 8 | 1687448 | | 1632834 | |
| | General | 35 | 554977 | | 624528.4 | |

*DF: Degree of freedom

Table 6. Comparing of Treatment Averages with Orthogonal and Duncan' Multiple Range Test Methods*

| Treatm | 1996 | | 1997 | |
|---|---|---|---|---|
| | Average Yield | $S_{\bar{x}}$ | Average Yield | $S_{\bar{x}}$ |
| SL | 2479.3 a | 161.8 | | |
| SGL | 2457.5 a (Total Yield) | | | |
| SG | 1965.9 b | | | |
| S | | | 4147 a | 196.5 |
| D | | | 3683 b (Total Yield) | |
| MS | | | 3769 a | |
| MD | | | 3108 b (Marketable Yield) | 68 (Irrigation Method) |
| PD | | | 2872 c | 136 (Variety) |
| PS | | | 2870 c | |

*Treatments shown with same letters are in same yield class at 5% confidence level

*Quality Properties*

Average values of some parameters related to quality properties of treatments were given in Table 7. These parameters contain second quality yield, fruit diameter and length, fruit weight and total soluble solids (Srinivas et al., 1989b; Sezgin et al., 1997).

Generally, significant differences were not found between treatments. Some quality properties were not influenced by the irrigation methods and nitrogen levels, except fruit diameter and fruit length. Fruit diameter was found different in varieties at 5% significance level. Fruit diameter of *M* was higher than *P*'s ($p<0.05$). In the same way, variety-nitrogen-irrigation-interaction influenced on fruit length. Therefore, treatments were constituted 7 groups that were different from each other. It can be concluded that the longest fruit length was measured in *P-DL* treatment. It is followed by *SL* and *DG* treatments in the same variety. In addition, fruit length was increased under drip irrigation in *P* variety.

Table 7. Some Quality Properties of the Treatments*

| Variety | Treatments | Second Quality Yield (kg da$^{-1}$) | Fruit Diameter (cm) | Fruit Length (cm) | T.S.S.W. (%) | Fruit Weight, (g) |
|---|---|---|---|---|---|---|
| P | SG | 941$^{ns}$ | 19.4 b | 25.5 b | 9.0$^{ns}$ | 5020$^{ns}$ |
| | SGL | 890$^{ns}$ | 19.3 b | 25.0 bc | 8.5$^{ns}$ | 4969$^{ns}$ |
| | SL | 897$^{ns}$ | 18.9 b | 25.6 ab | 8.8$^{ns}$ | 5055$^{ns}$ |
| | DG | 822$^{ns}$ | 18.5 b | 25.8 ab | 10.4$^{ns}$ | 4687$^{ns}$ |
| | DGL | 619$^{ns}$ | 18.2 b | 23.4 c | 10.0$^{ns}$ | 4099$^{ns}$ |
| | DL | 547$^{ns}$ | 18.8 b | 26.2 a | 9.6$^{ns}$ | 5107$^{ns}$ |
| M | SG | 790$^{ns}$ | 21.1 a | 22.5 cd | 8.6$^{ns}$ | 5030$^{ns}$ |
| | SGL | 806$^{ns}$ | 20.2 a | 21.5 e | 8.8$^{ns}$ | 4835$^{ns}$ |
| | SL | 919$^{ns}$ | 21.2 a | 21.4 e | 9.0$^{ns}$ | 4921$^{ns}$ |
| | DG | 839$^{ns}$ | 20.7 a | 22.6 cd | 10.6$^{ns}$ | 4996$^{ns}$ |
| | DGL | 649$^{ns}$ | 21.1 a | 22.4 cd | 10.5$^{ns}$ | 5236$^{ns}$ |
| | DL | 681$^{ns}$ | 20.8 a | 22.5 cd | 9.4$^{ns}$ | 5212$^{ns}$ |

*Treatments shown with same letters are in same yield class at 5% significance level

## CONCLUSIONS

In the study, different watermelon varieties, irrigation methods and nitrogen levels with forms were investigated under Cukurova conditions. There is no statistically significant difference between yields of two watermelon varieties. Varieties gave similar results under all conditions such as irrigation method and nitrogen level. However, it can be concluded that yield of *M* variety was greater than *P*'s in some applications. These results could be coincidence since they were not proved statistically. Therefore, further studies are needed for better understanding. Sprinkler irrigation method seems to be suitable method for watermelon irrigation. Especially, in M variety, higher yield was obtained from this method.

There was no significant difference between yields with various nitrogen amounts and application types. However, yield of watermelon was increased by nitrogen applied through irrigation water. Similar yields were obtained from liquid nitrogen that was about the half of granule nitrogen applied. The application nitrogen fertilizers at the planting time did not affect on the yield and quality of watermelon. Liquid nitrogen can be applied during the branching growth period. If granule nitrogen sources are used in that period, it may result in some damage in the watermelon plants. Application of liquid nitrogen through irrigation water (*fertigation*) is suggested because it seems to be a practical way for obtaining higher yields.

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## REFERENCES

Alavoine F., Crochon M., Fallot J., Moras P., Pech J.C., 1988. Test quality in fruit. Practical Methods of Analysis. CEMAGREF French Inst. of Agric. And Environ. Engin. Resear., Aix-En-Provence, France, p. 1-20.

Cetin O., Nacar A.S., 1997. Harran ovasi'nda karpuzun alttan sizdirma (gozenekli borular) sulama sistemiyle sulama olanaklari. GAP 1. Sebze Tarimi Sempozyumu (Turkish press).

Desai J.B., Patil V.K., 1984. Effects of M, P and K on the fruit yield of watermelon. J. Maharashtra Agric. Univ., 9:309.

Doorenbos J., Kassam A.K., 1979. Yield response to water. Irrigation and Dainage Paper, United Nations, Rome, No. 33, 193 p.

Faostat 2015. Food And Agriculture Organization of the United Nations Statistics Division, http://faostat.fao.org.

Goldberg D., Gornat B., Rimon, D., 1976. Drip irrigation. Drip Irrigation Scientific Publications, Israel.

Gunduz M., Kara C., 1996. GAP Bolgesi, Harran ovasi kosullarinda acik su yuzeyi buharlasmasina gore karpuz su tuketimi. Toprak ve Su Kaynaklari Arastirma Yilligi: 1995, KHGM-APK Dairesi Baskanligi Yay., 98: p. 258-269 (Turkish press).

Hanks R.J., Keller J., Rasmussen V.P., Wilson G.D., 1976. Line Source Sprinkler for Continuous Variable Irrigation-Crop Production Studies. Soil Sci. Soc. Am. J. 40: p. 426-429.

Kanber R., Yazar A., Ozekici B., Diker K., Unlu M., Sezen M., 1994. Bitki uretim fonksiyonlarinin eldesinde cizgi kaynakli yagmurlama sistemlerinin kullanilmasi. C.U. Zir. Fak. Dergisi. 9 (1): p. 133-148 (Turkish press).

May 1995. Tohum katalogu. MAY Tohumculuk Sirketi, Adana, 4 p. (Turkish press).

Ozbek H., Dinc U., Kapur S., 1974. Cukurova universitesi yerlesim sahasi topraklarinin detayli etud ve haritasi. C.U. Zir. Fak. Dergisi. 23: 149 p. (Turkish press).

Papazafiriou Z.G., 1980. A compact procedure for trickle irrigation system design. ICID Bulletin, 29 (1): p. 28-45.

Sapeksa, 1995. Tohum katalogu. SAPEKSA Tohumculuk Sirketi, 4 p. (Turkish press).

Sezgin F., Bas T., Yoltas T., Bas S., 1997. Aydin bolgesinde degisik ekim zamani sulama araliginda yetistirilen karpuz bitkisinin verim ve kalite ozelliklerinin belirlenmesi. GAP 1. Sebze Tarimi Semp. Urfa. p. 223-230 (Turkish press).

Srinivas K., Hegde D.M., Havagani G.V., 1989a. Growth analysis of watermelon in relation to drip and furrow irrigation. Indian Journal of Agronomy, 34 (2): p. 222-227.

Srinivas K., Hegde D.M., Havagani G.V., 1989b. Irrigation studies on watermelon (*Citrullus lanatus* (Thunb) Matsum et Nakai). Irrig. Sci., 10: p. 293-301.

Stanley C.D., Maynard D.N., 1990. Vegetables. "Irrigation of agricultural crops. Edit. B.A. Steward ve D.R. Nielson" ASA, CSSA, ve SSSA, Agronomy No. 30, Madison, Wisconsin, p. 921-949.

United State Salinity Laboratory Staff (USSLS) 1954. Diagnosis and improvement of saline and alkali soils. Agriculture Handbook No: 60, USDA, 160 p.

Yurtsever N., 1984. Deneysel istatistik metotlar. Toprak ve Gubre Arastirma Enstitusu Yay. No. 121(56), Ankara, p. 202-319 (Turkish press).

Zuang H., 1982. La Fertilization des cultures legumieres. CTIFL Publ., Paris, 397 p.