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ARAŞTIRMA MAKALESİ **RESEARCH ARTICLE**

The effect of nitrogen levels on yield and yield parameters of sweet corn (*Zea mays saccharata* Sturt.) growing in Diyarbakır Districts of Turkey

Diyarbakır ilinde yetişen tatlı mısırda (*Zea mays saccharata* Sturt.) farklı azot seviyelerinin verim ve verim parametreleri üzerine etkisi

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ABSTRACT

Nitrogen is a critical nutrient that is vital for enhancing plant growth and productivity. The influences of nitrogen (N) fertigation on yield, quality parameters, and nitrogen use efficiency of sweet corn (*Zea mays saccharata* Sturt.) under South Eastern Anatolia Region (Diyarbakır) conditions in Türkiye were investigated in that trial. Fertigation applications were executed under regional conditions in Diyarbakır during the 2015 and 2016 growing seasons on the experimental land of GAPUTAEM (GAP International Agricultural Research and Training Center). The BATEM (Batı Akdeniz Agricultural Research Institute) Tatlı variety of sweet cornwas utilized as the plant material. Five different N applications (0-75-150-225-300 kg ha^{-1}) were implemented on trial plots through a fertigation system. N levels implemented via the fertigation system had a significant effect on the days of tasselling, plant height, fresh husked ear yield (FHEY) and fresh unhusked ear yield (FUEY), chlorophyll rate, and nitrogen use efficiency ($p \leq 0.01$). Fresh husked (1918 kg ha^{-1}) and unhusked (1342.50 kg ha^{-1}) ear yields of sweet corn under the effect of 150 kg ha^{-1} nitrogen treatment were the highest. The maximum chlorophyll rate was (53.14%) recorded at 225 kg ha^{-1} N. Nitrogen use efficiency (NUE) increased with decreasing N supply, and the maximum NUE was observed from 75 kg ha^{-1} N application. The study findings indicate that the application of 150 kg N ha^{-1} using a fertigation method is important and environmentally conscious for the production of sweet corn.

ÖZET

Azot, bitki yetiştiriciliği süresince eksikliği en çok hissedilen aynı zamanda en fazla ihtiyaç duyulan ve verimde artış sağlayan bitki besin elementlerinin en önemlisidir. Bu araştırma, fertigasyon yöntemiyle uygulanan farklı azot uygulamalarının (0-75-150-225-300 kg ha^{-1}) tatlı mısırın (*Zea mays saccharata* Sturt.) verim, verim parametreleri ve azot kullanım etkinliği açısından değerlendirilmek amacıyla Diyarbakır GAP Uluslararası Tarımsal Araştırma ve Eğitim Merkezi Müdürlüğü üretim alanında 2015 ve 2016 yıllarında yürütülmüştür. Çalışmada BATEM tatlı mısır çeşidi kullanılmıştır. Çalışma sonuçları incelendiğinde azot dozlarının çiçeklenme gün sayısı, bitki boyu, kavuzlu taze koçan verimi, kavuzsuz taze koçan verimi, klorofil oranı ve azot kullanım etkinliği üzerine önemli etkisi olduğu belirlenmiştir ($p \leq 0.01$). En yüksek kavuzlu taze koçan (1918 kg ha^{-1}) ve kavuzsuz taze koçan (1342.50 kg ha^{-1}) veriminin 150 kg ha^{-1} azot dozu uygulamasından, en yüksek klorofil oranı değerinin (%53.14) ise 225 kg ha^{-1} azot dozu uygulamasından elde edildiği gözlemlenmiştir. Azot kullanım etkinliği değerinin azalan azot dozu uygulamaları ile artış gösterdiği ve en yüksek azot kullanım etkinliği değerinin 75 kg ha^{-1} azot dozu uygulamasından elde eldildiği görülmüştür. Çalışma sonucunda sürdürülebilir tatlı mısır yetiştiriciliği için fertigasyon yöntemiyle uygulanan 150 kg ha^{-1} azot dozu önerilebilir bulunmuştur.

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INTRODUCTION

Worldwide maize, (*Zea mays* L.), wheat, and rice production accounted for 90% of the total cereal production. Corn, wheat, and rice are the main sources of calories for approximately 94 developing countries in the world (Shiferaw et al., 2011). The global production of cereals reached up to 64 million metric tones in the 2020 and 2021 growing seasons, indicating a 4.1% increase in maize production (FAO, 2021). It is considered that corn (*Zea mays* L.), also known as maize, came from the wild grass in Central Mexico 7,000 years earlier and was consumed by Native Americans as a nutritious food source that can be utilized in a variety of food and industrial outputs, such as starch, flavoring, oils, adhesives, alcohol, beverages, or fuel ethanol. Sweet corn (*Zea mays saccharata* Sturt.), considered sugar corn, is a hybridized variety of corn, particularly crossbreed to enhance the sugar content, that reaches green ears in 75 to 90 days after sowing. It originated in the United States of America and has since spread to countries around the world. The kernels of sweet corn are much sweeter (25%) than the other types of corn, and their quality is based on the type of gene involved in sweetness (Najeeb et al., 2011). It is mainly used for food in the form of canned products through industrial processing and fresh consumption on the market, and it is increasingly popular as a vegetable choice (Caniato et al., 2007). Due to the high unit price, cultivating sweet corn can be financially beneficial for producers in small areas close to major cities (Pereira et al., 2009).

A number of dishes with sweet corn are becoming more and more popular in the world, including Türkiye. Türkiye's farmland and water resources are located in the Southeast Anatolian project area, where it is estimated that 1.7 million hectares of agricultural area will be available for irrigation Following the project's implementation, this region will cultivate sweet corn through a crop rotation system. In the area of Southeast Turkey, where local agricultural treatments and irrigation projects are being implemented, initial researches (Kılınç et al., 2023) indicate that the cultivation of sweet corn is viable, and Öktem and Öktem (2006) also stated that different varieties of sweet corn (Vega, Martha, Merit, Jubilee, and Reward) can be cultivated in the Southeastern Anatolia Region. Water has a crucial role in humans daily lives which is a key parameter in agriculture production, as it is in corn production. Even though water covers most of the Earth’s surface, agricultural water availability has been declining day by day. Meanwhile, insufficient rainfall causes a decline in groundwater levels (Arshad, 2020). Applying modern irrigation technologies in agriculture has become more significant as a consequence of declining water resources, increasing polulation, and industrialization. One of the most modern irrigation techniquees is drip irrigation, a method that distributes water around roots in small quantities concentrated so as to keep soil moisture at the desired level for plant growth. Since water is supplied close to the root area of the plant through the drip irrigation method, the amount of water that evaporates and seeps into the soil is very low, and therefore the water application efficiency is high. Drip irrigation is considered a competent method to increase crop yield if appropriate fertilizers are implemented through the fertigation method. Optimum fertigation can decrease fertilizer applications by 25% in order to achieve economic improvements in crop cultivation (Chauhdary et al., 2019). Nitrogen (N) is a primarily deficient yet fundamental nutrient in the cultivated soils of the world (Fageria et al., 2010), which is also one of the most important plant nutrients that limits crop productivity. Compared to most other crops, corn requires a relatively high level of nitrogen fertilization. Based on the expected yield, the suggested N level for field corn is between 134 and 269 kg ha^{-1} when grown in grain and 134 to 202 kg ha^{-1} when growing silage (Savoy, 1996). In order to achieve maximum profitability and productivity, specific N proposals are essential for the cultivation of sweet corn. The optimal nitrogen level for application may differ depending on the variety and environmental circumstances (Sezer & Yanbeyi, 1997). Kara (2006), observed that N management treatments (0, 90, 180, 270, and 360 kg ha^{-1}) improved plant height, first ear height, stem thickness, ear length, number of kernels per ear, thousand kernel weight, grain yield, and the nitrogen rate in the grain. While the maximum NUE (Nitrogen use efficiency) value was attained from 90 kg ha^{-1}, 18 cm row spacing, and 270 kg ha^{-1} nitrogen dose was determined to be recomendable for the 31G98 hybrid variety. Commercial fertilizers are not used in a balanced and economical way in Türkiye. Determining the appropriate fertilizer level is also important for the country's economy (Can & Akman, 2014). In various environments, sweet corn has shown different responses to N. Due to increasing nitrat pollution in water systems and high fertilizer costs, producers are looking for management strategies that could increase nitrogen use efficiency and economic return. In this manner, some researchers carried out studies to figure out the problem. Three different nitrogen levels (143, 286, and 429 kg ha^{-1}) were tested with three different hybrid corn varieties by Hassanein et al. (2007). With drip irrigation system, the maximum yield was obtained at the 429 kg ha^{-1} nitrogen level, and the highest NUE was attained at the 286 kg ha^{-1} N treatment. Even though several field experiments have shown the influence of surface, drip irrigation, and different N applications through fertigation systems on grain maize (Ramulu et al., 2010), only few have been stated on sweet corn with drip irrigation with different N treatments via fertigation. The initial study by Turgut (1998) stated that the maximum fresh ear yield for the Merit sweet corn variety was obtained at 280 kg ha^{-1} nitrogen level according to the regression analysis of five nitrogen applications (0, 100, 200, 300, and 400 kg ha^{-1}), which were implemented by the surface irrigation method. Similarly, in the South Eastern Anatolia Region, experiments have been executed to determine the appropriate variety and planting time for sweet corn by applying surface irrigation methods. Researchers have not conducted any fertigation-based studies to determine the appropriate nitrogen application rate for sweet corn. The purpose of that trial was to demonstrate the effects of different N treatments on yield and quality parameters of sweet corn by fertigation system under Diyarbakır ecological circumstances.

MATERIALS and METHODS

The experiment was executed in the 2015-2016 growing seasons in the study area of the GAP International Agricultural Research and Training Center (GAPUTAEM) in Diyarbakır, Türkiye. In terms of organic matter, the research area is very poor, and no problems have been identified with salinity. In winter, the soil profile expands due to the high content of clay minerals, and deep cracks fall 80 to 90 cm subsurface in the summer (Gürsoy et al., 2006). With the help of an auger, soil samples were obtained from a depth of 0 to 30 cm and examined in the GAPUTAEM Laboratory, and Table 1 shows the results.

Table 1. Some soil features of experimental site
Çizelge 1. Deneme alanına ait bazı toprak özellikleri

YEARS	2015	2016
Texture	Clay-Loam (C-L)	Clay-Loam (C-L)
EC (dS m^{-1})	1.65	0.90
pH	8.10	8.25
$CaC0_3$ (%)	9.97	11.00
P_2O_5 (kg ha^{-1})	3.21	4.02
K_2O (kg ha^{-1})	243	243
Organic Matter (%)	0.95	1.10
Bulk Density (g cm^{-3})	1.33	1.25

The Diyarbakır region is dominated by a continental climate, so the trial was carried out. According to the meteorological station's readings, the average temperature in the center of town is 31°C, and it has been 1.8 °C for the coldest month. On July 21, 1937, the maximum temperature recorded was 46.2 °C and the lowest was 24°C on January 11, 1933. Only approximately 2% of the annual mean precipitation (496 mm) occurs during the summer months. The precipitation will rise as you approach the foothills of the northern mountains. Artificial lakes like Karakaya, Atatürk, Batman, and Silvan dams, which have been installed in the last few years, constitude large evaporation subsurfaces. As a consequence the relative humidity in Diyarbakır has increased. From July to August, the level of humidity in the Diyarbakır basin will fall to 20% (Anonymous, 2017). Table 2 provides meteorological data and long-range mean values for the years in which research has been carried out.

Table 2. Monthly data of the climate in Diyarbakır for long period and during the 2015-2016 growing season of sweet corn

Çizelge 2. Diyarbakır ili 2015-2016 üretim sezonu yılları ve uzun yıllar iklim verileri

Meteorological values	Years	April	May	June	July	August
	Long Years	13.8	19.2	26.3	31.1	30.4
Average temperature (°C)	2015	12.4	18.8	26.1	31.7	30.9
	2016	15.7	19.9	26.8	31.6	31.9
	Long Years	20.4	26.5	33.6	38.4	38.2
Average maximum temperature (°C)	2015	19.2	27.1	34.4	40	39.3
	2016	23.7	27.5	34.7	39.2	40.5
	Long Years	7.2	11.3	16.9	21.8	21.1
Average minimum temperature (°C)	2015	5.5	10.3	15.9	21.4	21.2
	2016	7.1	11.6	17.3	22.5	22.1
	Long Years	68.2	42.9	8.1	0.7	0.4
Monthly average rainfall (mm)	2015	48.6	48.2	7.4	0	0
	2016	29	41.4	18.4	0	0.2

References: Diyarbakır meteorological directorate https://www.mgm.gov.tr/; *among 1950-2014 years

Characteristics of the plant material

BATEM TATLI, Turkey's first domestic sweet corn variety, was developed by the Western Mediterranean Agricultural Research Institute and registered in 2013. The variety is a standard type of sweet corn variety with a mean value FHEY (Fresh husked ear yield) of 15130 kg ha^{-1} and FUEY (Fresh unhusked ear yield) of around 5890 kg ha^{-1}. Crude protein (10.7%), crude fat (6.7%), starch (53.3%) and sugar (4.8%) contents were detected in BATEM TATLI (Anonymous, 2014).

Irrigation system and treatments

The trial was conducted as a randomized complete block design with four replications. Tillage, disk, land leveling, and ridge creation were performed before sowing. Sweet corn seeds were sown by hand with 70 cm by 20 cm row spacing, 5-6 cm planting depth, and 71400 seeds per hectare on April 20 and 25, 2015 and 2016, respectively. The experiment consisted of 20 plots in total, with 5 plots in each block. All measurements were collected from two rows in each parcel, and all treatments have been harvested at the milk stage. The harvest time was decided upon the method of thumbnailing. (Çetinkol, 1989). In both years, the first irrigations were applied by sprinkler irrigation for uniform germination, and thr gravimetric method was used for measuring the water content in soil. A 30 cm layer was applied to a depth of 90 cm on each plot, and irrigation water was applied to fill up to the field capacity. Other irrigations were applied by means of a drip irrigation system with a 5-day interval corrected with the wetting area ratio according to the evaporation amount measured from Clas A Pan. Before the installation of the system in the field, all measurements had been performed on the basis of soil and plant characteristics. Inline drippers were positioned at 33 cm intervals in the 16mm-diameter lateral pipes carrying 4 L h of water. During the drip irrigation treatment, soil water content was calculated via the gravimetric method every week. As a consequence of the irrigation water analysis, the electrical conductivity value was determined as (EC) = 0.60 dS m^{-1} and pH = 7.6.

The amount of water used for irrigation has been defined based on the Class A pan evaporation, utilizing the given equation.

$$I = A.Ep.Kpc.P$$ **Eq(1)**

Where I equals quantity of irrigation water (L), A equals parcel area (m^2), Ep equals cumulative evaporation quantity for 5-day intervals (mm), kpc equals coefficient (including pan coefficient kp and crop coefficient kc), and P equals wetted area (%). The methods described by Keller and Bliesner (1990) showed that the wetted area was 90% when field tests were conducted. Plant water consumption was estimated using the water balance equation and soil water measurements obtained through gravimetric samples of plants. Water consumption of plants was determined the amount of irrigation and precipitation plus water leakage to deep and soil water content variability during the season. The water balance equation is as follows:

$$ET = I + P \pm DS - D$$ **Eq(2)**

where: ET is evapotranspiration (mm), I irrigation (mm), P precipitation (mm), D deep percolation (mm) and DS is change of soil water storage. Deep percolation losses below the root zone were assumed to be negligible in the study because irrigation water was implemented on the basis of field capacity. During both growing seasons, the variation of soil water content at 0-30, 30-60 and 60-90 cm soil layers was continuously defined once every fifteen days through the gravimetric method (oven dry basis). During the 2015 cultivation period, 520 mm of irrigation water was implemented and 476 mm in 2016. Crop evapotranspiration was calculated at 554 and 495 mm for 2015 and 2016, respectively. Weed control and chemical pesticide applications were carried out throughout the plant growing season. Five pure nitrogen doses (0, 75, 150, 225 and, 300 kg ha^{-1}) were implemented in the trial. Considering the soil analyzed in both years of the experiment, a total of 100 kg ha^{-1} (P_2O_5) phosphorus and 1/5 of the stated nitrogen implemented equally to each parcel for base fertilizer and the rest (4/5) of nitrogen was implemented equally once every two irrigations by the fertigation method until a week before harvest (Çetin & Tolay, 2009). Potassium fertilization was not applied because the available potassium content of the soil was detected to the sufficient in the soil samplings obtained from the cultivation area in both growing seasons. The harvest was carried out at the milk stage of the plants on August 1 and August 3, 2015 and 2016, respectively. In the trial, chlorophyll rate, tasselling days, plant height, FHEY, FUEY, and NUE values were explored. In the middle of two rows for each parcel, observations on plant height and chlorophyll levels have been made from 10 randomly chosen plants, while fresh ear yields (husked and unhusked) were attained from every plant in the middle of a pair of rows. Days of tasseling were recorded when 50% of plants produced tassels. The study performed calculations of the investigated properties using the methods outlined in the Ministry of Agriculture and Forestry's Agricultural Values Measurement Trials Technical Instruction (Anonymous, 2015). Leaf chlorophyll contents were measured by a Minolta SPAD-502 chlorophyll content meter in the pick tasseling stage. The data obtained in the study were evaluated via the JMP 5.1 statistical package. The analysis of Variance (ANOVA) and Least Significant Difference (LSD 0.05) tests were attained by combining of two years.

RESULTS and DISCUSSIONS

The parameter commonly measured by plant scientists is leaf chlorophyll content. This data is fundamental for understanding a plant's response to the environment.

The statistical difference ($p \leq 0.01$) between the years and applications and the year × application interaction is observed to be insignificant for chlorophyll rates (Table 3). The chlorophyll content (SPAD) measured in 2015 with a 51.70 value and the nitrogen rate of 225 kg ha^{-1} with a 53.14 value were higher. The chlorophyll content in the leaf increased as the nitrogen doses increased until 225 kg ha^{-1} N application, but a farther increase in the N rate (300 kg ha^{-1}) had no important effect. The results were parallel with the study of Tunalı et al. (2012), who reported a positive relationship among nitrogen doses and chlorophyll content. Commonly, an increase in the amount of chlorophyll is regarded as a parameter that corresponds to an increase in photosynthesis (Bashan et al., 2006).

Table 3. Influence of different nitrogen rates on some properties of sweet corn in the 2015-2016 growing seasons
Çizelge 3. Farklı azot seviyelerinin 2015-2016 üretim sezonu yıllarında tatlı mısırın bazı özellikleri üzerine etkisi

		N applications					
	Years	**0 kg ha^{-1}**	**75 kg ha^{-1}**	**150 kg ha^{-1}**	**225 kg ha^{-1}**	**300 kg ha^{-1}**	**Mean**
	2015	44	52	53	56	55	52 a
Chlorophyll content**	2016	40	46	50	51	49	47 b
	Mean	42 c	49 b	52 ab	54 a	52 a	
	CV (%)	5.9	LSD $_{(0.05)}$: Nitrogen Doses:2.9			LSD $_{(0.05)}$: Years:1.4	
	2015	69	66	66	67	68	67 a
Tasseling period (day)**	2016	66	64	64	65	65	65 b
	Mean	68 a	65 c	65 c	66 bc	66 b	
	CV (%)	1.2	LSD $_{(0.05)}$: Nitrogen Doses:0.9			LSD $_{(0.05)}$: Years:1	
	2015	176	196	201	203	195	194
Plant height (cm)**	2016	184	199	193	189	192	192
	Mean	180 b	198 a	197 a	196 a	193 a	
	CV (%)	4.2	LSD $_{(0.05)}$: Nitrogen Doses:8.34				
	2015	14238	18288	22283	21008	16838	18530 a
Fresh husked ear yield (kg ha^{-1})**	2016	9398	14036	16078	13318	12913	13149 b
	Mean	11818 c	16162 b	19180 a	17163 ab	14875 b	
	CV (%)	16	LSD $_{(0.05)}$: Nitrogen Doses:255			LSD $_{(0.05)}$: Years:297	
	2015	10088	13200	16675	14800	11588	13270 a
Fresh unhusked ear yield (kg ha^{-1})**	2016	6270	8383	10175	8123	8053	8201 b
	Mean	8179 c	10792 b	13426 a	11462 b	9820 bc	
	CV (%)	16	LSD $_{(0.05)}$: Nitrogen Doses:174			LSD $_{(0.05)}$: Years:215	
	2015	0	176	111	66	39	78
NUE **	2016	0	187	107	59	43	79
	Mean	0 e	181 a	109 b	62 c	40 d	
	CV (%)	23	LSD $_{(0.05)}$: Nitrogen Doses:19				

** significant at the level of 0.01; * significant at the 0.05 level

Applying different rates of N fertilization affected the tasseling days of sweet corn, and tasseling days ranged between 63.75-69.00 (Table 3). Tasseling period was highly significantly affected (p≤0.01) by nitrogen rates. Compared to other N applications, plants fed without N tasseled later (67.13 days). The longest tasseling day was recorded in 2015 (66.85 days), while the shortest was (64.35 days) in 2016. A fluctuation in the amount and distribution of precipitation over a period of two years may be the reason for reducing tasseling days during the 2016 growing season compared with 2015. No significant effects were observed about N levels × year interactions regarding the tasseling days. These findings align with Kara's (2006) report, indicating that increasing nitrogen levels shorten the number of tassel days. In the study, the effects of the years on FHEY and FUEY were defined as significant (p≤0.01). Increasing plant height owing to more nitrogen can be associated with more vegetative growth, which leads to increased mutual shading and internodal extension. Significantly highest plants obtained from 75, 150, 225, and 300 kg ha^{-1} N rates (197.25, 196.62, 195.38, and 193 cm) and 0 kg ha^{-1} (179.75 cm) produced the shortest plants (Table 3). The effect of years and year × application interactions was statistically insignificant for plant height. These findings are in conformity with Khan et al. (2005), who noticed that a decline in N causes a decline in plant height, and the highest plants obtained from 120 N kg ha^{-1} rate.

The analysis of the data revealed that different N-level applications had a significant (p≤0.01) effect on the FHEY of corn. Maximum (19180 kg ha^{-1}) and FUEY (13425 kg ha^{-1}) were recorded when N was applied at the level of 150 kg ha^{-1}, but further increases in the N rate for both years have a negative effect on FHEY and FUEY (Table 3). These results are in line with Kara (2006) and Yılmaz (2005), who emphasized that FHEY and FUEY increased with increasing nitrogen levels. Turgut (1998) stated that the highest yield of sweet corn fresh ears was at 280 kg ha^{-1} of nitrogen levels based on regression analyses at 0, 100, 200, 300, and 400 kg ha^{-1}. In the meantime, it should be taken into account that the surface irrigation method was applied in the study carried out by Turgut (1998). The effects of the years on FHEY and FUEY were defined to be significant ($p \leq 0.01$) in the study. The avarage value of FHEY and FUEY was higher in 2015 compared to 2016. The higher yield values of 2015 growing season can be attributed to the study being conducted on a fallow field.

Most of the cereal crops require a large amount of nitrogen to produce maximum yield. In maize, low NUE is noticed when a high proportion of the fertilizer N is not recovered by the plant. In terms of global wheat and corn production, NUE currently stands at 33% (Freeman & Raun, 2007). It depends on a number of factors, e.g., crop health, soil type, year, location, application timing, methods for applying fertilizers to the soil, and variety (Nielsen, 2006). Therefore, nitrogen management is one of the most serious issues in agriculture (Subedi et al., 2006). Agronomic NUE was computed as the rate of ear yield to the total N application for the particular treatment. NUE was affected by N applications and ranged from 0 to 187 kg in this study (Table 3). The highest nitrogen use efficiency rate was recorded at 75 kg ha^{-1} nitrogen level. A declining pattern in NUE rates with increasing fertilizer treatments indicates that plant cultivation could be sustained with lower fertilizer levels (Ramírez et al., 2005). As stated by Peng et al. (2011), low level of NUE can be due to nitrogen loss through ammonia denitrification, volatilization, or leaching into the environment.

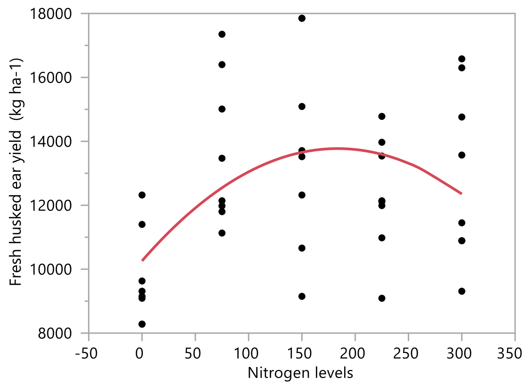

Figure 1. Influence of nitrogen levels on fresh husked ear yield of sweet corn

Şekil 1. Farklı azot seviyelerinin kavuzlu tatlı mısır verimi üzerine etkisi

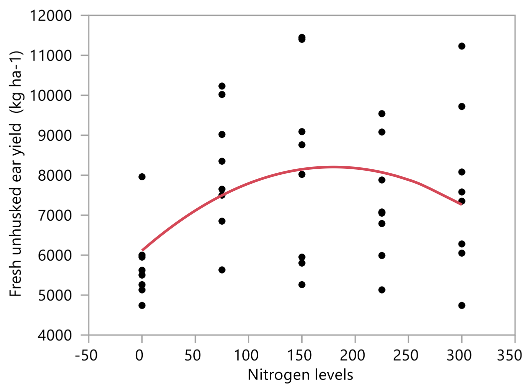

Figure 2. Influence of nitrogen levels on fresh unhusked ear yield of sweet corn

Şekil 2. Farklı azot seviyelerinin kavuzsuz tatlı mısır verimi üzerine etkisi

Regression analysis was performed to determine the association between nitrogen levels (X) and FHEY (Y). FHEY increased in a quadratic way for N rates (Figure 1). The relation between N levels and FHEY was formed by y: 1260.79 + 6.98X - 1.04 X^2 (R^2: 0.21) and the relationship between N levels and FUEY (Figure 2) based on y: 757.18 +3.83 X - 0.64 X^2 (R^2: 0.15) equation. Increase N levels up to 150 kg ha^{-1} leads to an increase in FHEY and FUEY. Lower FHEY and FUEY values were attained at 225 and 300 kg ha^{-1} N rates, respectivetely. A previous study, in which the recommended N level for sweet corn was 300 kg ha^{-1} under surface irrigation conditions, was performed in the same field that this study was conducted (Kılınç et al., 2023). However, in the mentioned study, it has been detected that applying only 150 kg ha^{-1} of nitrogen using a fertigation system can result in the highest sweet corn yield, which is only half of the recommended nitrogen level. This finding not only helps reduce the production cost for producers but also helps prevent soil and water pollution, which is vital for sustainable agriculture.

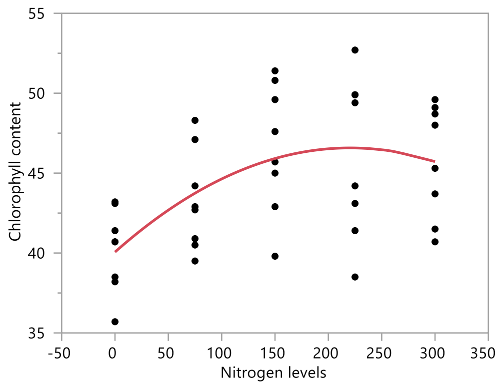

Figure 3. Influence of nitrogen levels on chlorophyll content

Şekil 3. Farklı azot seviyelerinin klorofil oranı üzerine etkisi

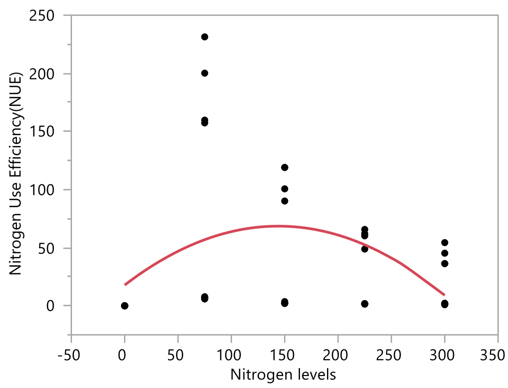

Figure 4. Influence of nitrogen levels on NUE

Şekil 4. Farklı azot seviyelerinin azot kullanım etkinliği üzerine etkisi

The relationship between chlorophyll content and N concentration is strong and undeniable, and the photosynthetic rate of a plant is directly related to the amount of chlorophyll available in its leaf tissue. Plants produce less chlorophyll and have reduced cell turgidity under N deficiencies (Fageria et al., 2010). A significant correlation between the chlorophyll content and the different N concentrations was observed in the regression analysis, and the relationship was interpreted according to y: 43.08 + 0.18 X- 0.013 X^2 (R^2: 0.30) the equation. The chlorophyll content increased when N was implemented at a rate of 225 kg ha^{-1} and obtained lower values from the 300 kg ha^{-1} N level. When tissue or soil analysis is not avaailable, the chlorophyll content of plant leaves can be utilized for the purpose of determining the N status of the plant as an alternate measure (Schepers et al., 1992).

Plants have a high demand for N, which supports photosynthesis, leaf formation and expansion, as well as stem and root growth during vegetative growth. The evaluations on improved N fertilizer recommendations will increase fertilizer NUE and N fertilizer consumption. In general, the use of nitrogen fertilizers in crops is below 50%. The N levels are significantly affected by mechanisms such as denitrification, leaching, and volatilization (Webster et al., 1992). It is crucial to avoid excessive nitrogen fertilization. In order to increase the efficiency of nitrogen fertilizer application for better management practices, it is necessary to determine the most efficient way for N fertilization based on soil fertility analysis. Regression analysis was executed to investigate the relationship between nitrogen levels (X) and NUE (Y). The outcomes of the study indicated that NUE increased in a quadratic way as N levels increased up to 150 kg ha^{-1} with y: 92.68 + 0.41X - 0.30 X^2 (R^2: 0.26) equation (Figure 4). Due to the different climatic conditions, soil characteristics, plant varieties, and sowing dates, researchers recommended different N application levels for sweet corn. Among these management strategies, proper N application rates are critical for meeting plant N demands, improving NUE, and minimizing N losses (López-Bellido et al., 2006). Decidingon the most convenient N fertilization has a crucial role for economic viability, crop productivity, and environmental quality. Nitrogen fertilization has well documented increases in maize growth and yields in different parts of the world (Azeez et al., 2006; Barbieri et al., 2008; Riedell et al., 2009; Amanullah & Shah, 2010). In the semiarid area of Pakistan, 250 kg N ha^{-1} has been reported to be an appropriate level for maize (Hammad et al., 2011). According to Torbert et al. (2001) in Texas, the yield of corn grown with 168 kg ha^{-1} N fertilizer rate was in a year with sufficient precipitation. Likewise, Ma et al. (2005) found that the yield of corn rose by up to 120 kg N ha^{-1} in Ontario, Canada.

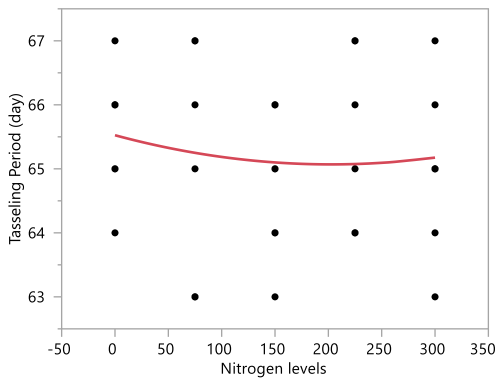

Figure 5. Influence of nitrogen levels on tasseling period

Şekil 5. Farklı azot seviyelerinin tepe püskülü çıkarma gün sayısı üzerine etkisi

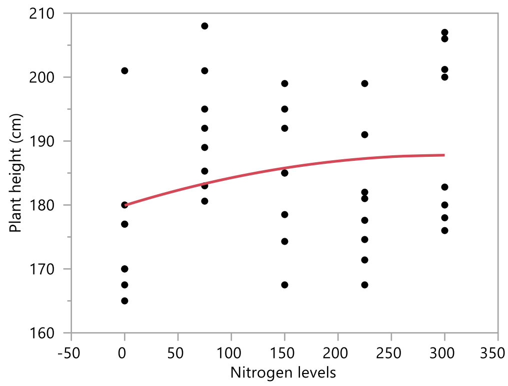

Figure 6. Influence of nitrogen levels on plant height

Şekil 6. Farklı azot seviyelerinin bitki boyu üzerine etkisi

Regression analysis was performed to determine the association between nitrogen levels (X) and the days of the tasseling (Y) and tasseling period showed a highly significant correlation with N levels (Figure 5). The relationship between them is viewed as $y: 65.27 - 0.011 X + 0.001 X^2$ (R^2: 0.01) the equation. Maximum days for tasseling were obtained from applying 0 N kg ha^{-1}, while minimum values were observed from 150, 225, and 300 N kg ha^{-1} levels, which means application of N for sweet corn shortened the tasseling period. Ramírez et al. (2005) informed that the sweet corn crop took 47 days for tasseling when N was applied at 130 kg ha^{-1} under semi-arid conditions.
Regression analysis expressed significant correlations of plant height with different N concentrations, and the relationship was formulised according to $y: 181.84 + 0.26 X - 0.008 X^2$ (R^2: 0.05) the equation (Figure 6). Plant height significantly increased with rising N level up to 75 kg ha^{-1} but a further increase in N rates had no significant effect on plant height. Amanullah et al. (2009) stated that raising N rates produced taller plants through applying 180 kg N ha^{-1} while the shorter plants were recorded in the plots that received the lowest level of 60 kg N ha^{-1}. The discrepancy in the results of Amanullah et al. (2009) and alterations in climatic circumstances, local soil properies at the trial lands, and species differences are likely to have contributed to the results of this study.
In conclusion, this experiment targeted evaluating the appropriate nitrogen level for sweet corn using the fertigation system, relying on two years of data. Chlorophyll rate values ranged from 41.58 to 51.89, the days of tasselling were between 64.75 and 67.13 days, and the plant height ranged from 179.75 to 197.25 cm. Increasing nitrogen application rates caused an increase in FHEY and FUEY of the BATEM TATLI sweet corn variety up to 150 kg ha^{-1} N level, while higher N applications (225 and 300 kg ha^{-1}) caused a decrease. The highest NUE was attained at a 75 kg ha^{-1} N rate. According to the outcomes of this study conducted in South East Anatolia Region, 150 kg ha^{-1} was considered the most appropriate N level for sweet corn by applying a fertigation system. However, further investigations are needed under field conditions by applying variable N levels to different sweet corn varieties.
There are very few studies on this fungal pathogen worldwide. Therefore, it is important to evaluate the biological control potential of this fungal species against potential pathogens. This study demonstrated the presence of *P. flexuosa* from sugar beet growing areas. Result is believed to guide researchers using this fungus as a biological control agent in future studies.

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STATEMENT OF CONFLICT OF INTEREST
The authors of the manuscript state that there are no conflicts of interest in terms of private or commercial interests within the scope of this study.

AUTHOR'S CONTRIBUTIONS
The authors of the manuscript declare that they have contributed equally to the study.

STATEMENT OF ETHICS CONSENT
Ethical approval is not applicable, because this article does not contain any studies with human or animal subjects.

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