Original Research Article

IMPACT OF DIFFERENT NITROGEN LEVELS TO THE GRAIN YIELD AND YIELD COMPONENTS OF SOME CORN (*Zea mays* L.) HYBRIDS

UNDER PEER REVIEW

ABSTRACT

Aims: The study was designed to elucidate the effect of different nitrogen (N) fertilizer levels on five different maize cultivars.

Study design:A split plot experimental design in randomized complete blocks (RCBD) with three replicates. Arrangement of seven nitrogen levels and five single cross hybrids were compared. Main plots were nitrogen levels and subplots were varieties.

Place and Duration of Study: College of Agricultural Engineering Sciences at the University of Duhok, Iraq. The study was undertaken fromMarch– August 2021.

Methodology: At the present research, five single cross-hybrid corn varieties were used, which were: CADZ, DKC6050, DRACHMA, MYIMY and ZP6468D. Arrangement of seven nitrogen fertilizer levels were 0, 50, 100, 150, 200, 250 and 300 kg N ha^{-1}. The following features were studied: plant height, leaf area index, thousand kernel weight, total grain yield, total chlorophyll, protein% and oil %.The collected data were projected to SAS software program for analysis. The significant differences between treatment means were calculated using Duncan's multiple ranges.

Results: It was reveal that there were significant effect of different nitrogen fertilizer levels, maize genotypes as well as the interaction of nitrogen and genotype of maize (P<.01) for plant height, leaf area index, 1000 kernel weight, total grain yield, total chlorophyll and protein %. However, There were no significant differences between different maize genotypes as well as different nitrogen fertilizer levels (P>.05) with oil %, but the interaction of nitrogen and genotype of maize was significant (P<.01).

Conclusion: Increasing the amount of nitrogen had better effect on studied characteristics of different maize varieties, in which adding 300 kg nitrogen had optimum results. In considering the response of maize varieties to nitrogen, the best variety was DRACHMA genotype while the worst variety was CADZ genotype, however this hybrids was superior in some traits.

Keywords: Fertilization, nitrogen, maize, grain yield, protein, oil

1. INTRODUCTION

Maize (*Zea mays* L.) is belonging to the Gramineae family in which was originated from the America continent. It was cultivated first in Mexico before 7000 years [1]. Maize is one of the popular grains in the world because of the increasing demand, mainly for the poultry feeding industries. Besides, maize has more diverse uses not only as food but also as raw materials in industry. Maize production have a growing tendency with the introduction of the hybrids and it is due to the fact that it has a high yield potential [2]. It is a crucial crop in different parts of the developed and developing countries. It ranks the second place after wheat in 2019 at the world [3].

Nitrogen plays an important role on almost all plants metabolism, including maize. Nitrogen is one of macronutrients for maize, and while nitrogen is one of the major elements on the earth, its deficiency might be the most common issue of nutrients in the farmers' experience. A major component of amino acids, in which is measured as the building units of proteins is nitrogen. It is definitely playing the major role in all plants as a component of chlorophylls, which is the green pigment found in the plants that is necessary for photosynthesis process. A suitable nitrogen availability in corn will allow the plant to obtain its genetic yield potential [4].Researchers reported many results concerning the significant importance of nitrogen to maize crop.

Depending on [5], nitrogen has an influence on the silage quality made of maize. They affirmed that the quality of the grain is considerably affected during nitrogen application, as plants that nourished well can produce higher nutritional value of silage. Studying agronomic traits combined with utilization of nitrogen, [6] stated in their conclusion that nitrogen fertilization significantly improved the quality grain through an increase in both protein and mineral contents, intervening positively in the ears number per one plant, ears weight, as the mass of a 1000 seeds increased regarding to the doses of nitrogen. Another vital factor to consider for determining nitrogen fertilization in the maize is the variance in nitrogen use and assimilation among different maize hybrids [7].

To examine the role of different nitrogen levels in maize yield efficiency under irrigation systems, many studies were undertaken [8 – 20] and all those researchers indicated that nitrogen fertilizers had a significant effect on maize yield characteristics.

In a study the authors used different nitrogen levels (50, 100 and 150 kg N ha^{-1}) on different maize genotypes at Haramaya, Eastern Ethiopia in years 2018 and 2019. They found that as combined data of their results displayed that only foremost effect of hybrid had greater significant effect on the ear length of maize, while other treatments were found to be non-significant. Some varieties produced longer ear length and other had shorter ones. This possibly will be because of the genetic differences of the 2 maize hybrids used [21].In a study of [22] who studied the effect of different N fertilizer levels on maize traits. They found the plant height was 238.5 cm when applying 150 kg nitrogen per hectare. They also found that applying nitrogen to the maize had increased oil levels significantly, in which oil % was increased from 2.03 to 2.87 % with applying 150 kg N ha^{-1}. In addition, N had increased protein and total chlorophyll levels significantly.

There is limited knowledge about nitrogen level and best type of maize in Dukok, Iraq. Therefore, the study was designed to elucidate the effect of different N fertilizer levels on five different maize cultivars to determine the optimum nitrogen level and the best corn variety for Dukok-Iraq.

UNDER PEER REVIEW

2. MATERIALS AND METHODS

2.1 Maize Hybrids

At the present research, five single cross-hybrid corn varieties were used, which were: Single cross CADZ (Spain), Single cross DKC6050 (American), Single cross DRACHMA (Switzerland), MYIMY (American) and ZP6468D (Serbia). These hybrids were brought from Erbil and College of Agricultural Engineering Sciences in University of Duhok, Duhok province.

2.2 Research Year and Location

This work was conducted in the College of Agricultural Engineering Sciences at the University of Duhok, Duhok, Iraq (Fig.1) where latitude, longitude and elevation 36°51'42.5"N, 42°51'57.6"E and 473m (a.m.s.l), approximately 12 km to the west of Duhok city center. The study was undertaken from March– August 2021.

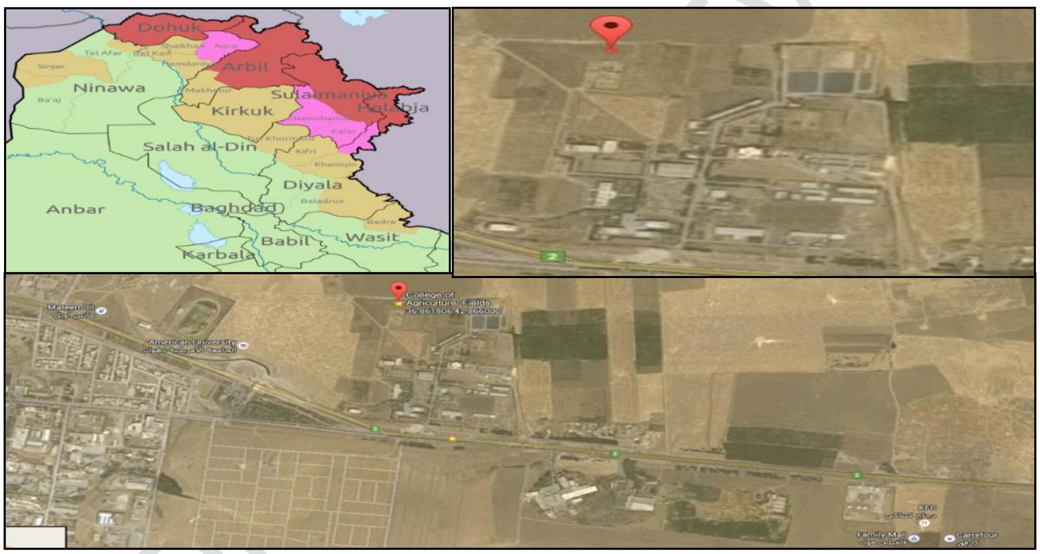

Fig. 1: The study site

2.3 Research Design and Layout

The present study was conducted on a split plot experimental design in randomized complete blocks (RCBD) with three replicates. Arrangement of seven N levels (0, 50, 100, 150, 200, 250 and 300 kg N ha^{-1}) and five single cross hybrids were compared. Main plots were nitrogen levels and subplots were varieties. The layout was 3 replicates (R1, R2 and R3). Each replicate was consisting of 7 plots. Each plot was divided to 5 subplots and each subplot was comprised of 4 rows of one hybrid with 5 m long, 70 cm between rows and 20 cm between plants within each row. Between each replicate, 5 m was left as a space and each plot was apart by 1 m from each other.

2.4 Cultural applications

2.4.1 Field preparation

The field of experiment was ploughed in March 2021 at 20 -25 cm depth, and then smoothing and leveling process was undertaken using Rotovator tool.

2.4.2 Sowing

After the completion of soil preparation, parceling process was done depending on the experimental design. After the parceling process (70 cm space between rows and 20 cm space between plants), the seed of plants were planted by placing two seeds in depth 5-6 cm in March. After planting, sprinkler irrigation was used so as to complete the planting process depending on the humidity of soil.

2.4.3 Fertilization

Before fertilizer application, there was an analysis of soil of experiment area. After that fertilization was done according to the results of analysis of soil when the plant reached 30-45 cm the second half of nitrogen was applied. The amount of nitrogen fertilizer needed for each treatment based on pure nitrogen from urea, based on a pilot scheme for each plot according to the exact area of each plot was calculated and distributed. This means that one third of N coincides with the planting, thinning to one – third and one –third of nitrogen in the 8 to 12 leaf stage were used and immediately irrigation. The pre planting was used herbicide atrazine to control weed at of 0.7 kg ha^{-1} coincides with the second irrigation was used and hard weeding were need.

2.4.4 Maintenance

After completing the germination, the first thinning (when the plants are 5-10 cm long) was performed by hand and the first hoeing was done after the plant reaches 15 to 20 cm length; whereas, the third hoeing was done after plant reaches 40 cm length. Weed was removed by hand after irrigation depends on the weed density. After completing of planting process, plants were irrigated (sprinkler irrigation) every 7 days based on the water needs of the plant.

2.4.5 Harvesting

Harvesting was done for each plot from two of middle rows (2*0.70*5 = 7 m^2) on the maturity. To study the characters of each plot, ten random plants were selected from the middle rows and the characters were measured on these plant samples.

2.5 Features studied in the experiment

2.5.1 Plant height (cm)

Plant height was measured from ground level to the first pedicel of panicle on the random selected 10 plants from each plot.

2.5.2 Leaf area index (cm^2)

The crop leaf area was measured by taking the width and length of each leaf. After that, using the following equation [23 – 25]. The measuring of the leaf area index was calculated using the following equation [26]:
Leaf area =0.75 (Length * width)

UNDER PEER REVIEW

LAI= $\frac{\text{Leaf area cm}^2}{\text{Area occupied by plant(s)cm}^2}$

2.5.3 Thousand kernel weight (g)

The weight of 1000 kernels samples was recorded at 15 % moisture content. After the grains were dried in oven, they were weighed so that to determine the percentage of the moisture, where the percentage of moisture adjusted to 15% by using the equation by [27].

2.5.4 Total grain yield (ton / ha)

Harvesting was done for each plot from two of middle rows on the maturity. Total grain yield was calculated as the total kernel weight of hectare. After the grains were dried in oven, they were weighed so that to determine the percentage of the moisture, where the percentage of moisture adjusted to 15% by using the equation by [28].

2.5.5 Total Chlorophyll

Total chlorophyll was determined using spectrophotometer apparatus in the laboratory and it was also measured using SPAD-502 (Konica Minolta) portable chlorophyll meter in the field. The chlorophyll was measured using SPAD-502 measuring at two-thirds of the distance from the tip of the leaf towards the plants stem. The 2 upper leaves were used in sampling.

2.5.6 Protein Content (%)

Protein percent was determined with micro Kjeldahl apparatus according to Kjeldhal method, by calculating nitrogen present then estimating protein percent according to flowing equation:
% protein = nitrogen * 6.25

2.5.7 Oil Content (%)

Seed oil content was determined by petroleum ether extraction method using Soxhlet apparatus (Fig. 2). The oil % was calculated as the initial weight – final weight * 100

UNDER PEER REVIEW

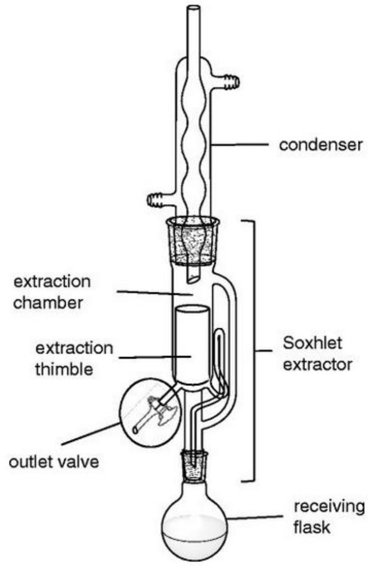

Fig. 2: **Soxhlet Apparatus**

2.6 Data Analysis

All the collected data were placed in Microsoft Excel spreadsheet to be prepared for analysis. Then the data were projected to SAS software program for analysis. The data of the adopted design (RCBD) were analyzed statistically by the analysis of variance (ANOVA), using SAS software (version 9.1, 2000); the significant differences between treatment means were calculated using Duncan's multiple ranges. Tables were prepared using Microsoft Excel Spreadsheet.

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

The response of the plant height of different maize hybrids to different nitrogen levels is illustrated in Table 1. There were significant effect of different nitrogen fertilizer levels, maize genotypes as well as the interaction of nitrogen and genotype of maize (*P*<.01). The highest mean of all genotypes was in response to 200 kg ha^{-1}of applied nitrogen fertilizer, whereas the lowest was control without applying any fertilizers. The highest plants were of genotype CADZ in response to 300 kg ha^{-1}nitrogen followed by the same genotype in response to 200 kg ha^{-1}nitrogen, which were 244.4 and 236.9 cm respectively. The lowest plants were of genotype ZP6468D in response to no (control) nitrogen, which was 189.23 cm. The highest mean was of CADZ and the lowest was ZP6468D hybrid.

Table 1.The effect of different nitrogen fertilizer levels on plant height (cm) of five maize genotypes.

Cult. / N kg ha^{-1}	CADZ	DK 6050	DRACHMA	MYIMY	ZP6468D	Mean N

0	221.96e-f	193.23 q*	212.30 g-n	195.86 p-q	189.23 q	202.52 c
50	231.30b-d	202.96 n-p	232.66b-d	209.56i-n	211.00 h-n	217.50ab
100	230.56 c-e	214.73 f-l	219.96 f-h	202.50 n-p	198.30 o-q	217.50a
150	240.60 ab	204.93m-p	215.46 f-k	205.86 k-o	203.93 m-p	214.16b
200	237.63a-c	217.40 f-j	234.83 bc	207.13 k-o	210.96h-n	221.59a
250	236.90a-c	207.56 j-o	223.80 d-f	209.40 i-n	204.63 m-p	216.46b
300	244.40 a	213.5 g-m	218.96f-i	208.56 j-n	220.20 f-h	221.12a
Mean	234.76 A	207.762 C	222.57 B	205.55 C	205.46 C	

** : There is no statistical difference among values annotated with the same letter at the each row and column according to Duncan test at P≤.05.*

Ali and Anjum [29] applied nitrogen fertilizer of 70 to 180 kg per hectare to maize. They found out that the highest mean of plant height was with applying of 180 kg ha^{-1}nitrogen fertilizer and was 210.23 cm whereas the minimum was with control. Similar results were found in the present research by increasing the nitrogen fertilizer amount, the plant height was increased until applying 200 kg N ha^{-1} and then decreased with higher amounts of fertilizers. Similarly, [29] concluded that the best and most economic amount of fertilizer is 180 kg per hectare. In another study undertaken by Aslam et al. [30] found the similar results. They achieved the highest plant with 150 kg N ha^{-1} which was 209.6 cm. In addition, Abo El-Ezz and Haffez [22] found the plant height was 238.5 cm when applying 150 kg N ha^{-1}. As a result, this research is in line with previous studies and the economic dose of nitrogen for plant height was 200 kgha^{-1}. Moreover, Khan et al. [31] found that plant height was significantly increased by adding nitrogen fertilizer to maize. The heights plants were found in adding 160 kg N ha^{-1}. They found that the plant height was increased more than 26 cm with adding 160 kg N ha^{-1} compared to control, which were non-fertilized plots. Amanullah et al. [32] and Jena et al. [33] also found similar results to the findings of the present study. The increase in the maize plant height with the rising in nitrogen application dose suggested that nitrogen was used plants during active cell division to form proteins for elongation of cell [34].

UNDER PEER REVIEW

3.2 Leaf Area Index (cm^2)

The response of the leaf area index of five different maize hybrids to different nitrogen levels is shown in Table 2. There were significant differences between different maize genotypes as well as different nitrogen fertilizer levels (*P*<.01), but the interaction of nitrogen and genotype of maize was not significant. The highest mean of all genotypes was in response to 300 kgha^{-1} of applied nitrogen fertilizer, whereas the lowest was control without applying any fertilizers. The highest leaf area index was in CADZ hybrid with 300 kgha^{-1} nitrogen fertilizer, which was 5.65 cm^2, whereas the smallest was in ZP6468D hybrid with no fertilizer, which was 3.94 cm^2.

Table 2. The response of the leaf area index (cm^2) of different maize hybrids to different nitrogen fertilizer levels.

Cult. / N kg ha^{-1}	CADZ	DK 6050	DRACHMA	MYIMY	ZP6468D	Mean N
0	4.76 b-i	4.11 i-j	4.55 h-j	4.38 h-j	3.94 j	4.35B
50	5.01 a-h	4-61 f-i	5.33 a-d	4.76 b-i	4.58 g-i	4.86AB
100	4.99 a-h	4.93 b-h	4.92 b-h	5.39 ab	5.21 a-g	5.09A
150	5.30 a-e	4.69 c-i	5.43 ab	4.65 d-i	4.86 b-h	4.98A
200	4.92 b-h	4.64 e-i	5.35 a-c	5.07 a-g	4.63 e-i	4.92A

250	5.31 a-e	4.58 g-i	4.99 a-h	5.38 a-c	4.78 b-i	5.01A
300	5.65 a	4.92 b-h	5.29 a-f	4.82 b-h	4.65 d-i	5.079 A
Mean	5.13 A	4.64 B	5.12 A	4.92 A	4.66 B	

** : There is no statistical difference among values annotated with the same letter at the each row and column according to Duncan test at P≤.05.*

Leaf area index is a measure of leafiness for each unit of ground area and denotes the extent of photosynthetic machinery [35]. In a study by Belay and Adare [21], who used different nitrogen levels, which were 50, 100 and 150 kg N ha^{-1}, on different maize hybrids at Haramaya, Eastern Ethiopia in two years 2018 and 2019. They found that the leaf area index of different maize hybrids was significantly affected by nitrogen fertilizers. Amanullah et al. [35] found that the effect of year and time of application of nitrogen had a significant effect of leaf area index. Whereas they found the effect of the combination of both plant density and time of application of nitrogen did not significantly affect the leaf area index [35]. In another research, Ali and Anjum[29] found that the increase in nitrogen fertilizer dose leads to an increase of leaf area index of maize plants. Additionally, Jena et al. [33] found that adding up to 240 kg ha^{-1} of nitrogen fertilizer per hectare had increased leaf area index from 1.33 to 3.89 cm^2 [33]. The findings of the present research are in agreement with the findings of the previous studies.

3.3 Thousand Kernel Weight (g)

There were significant differences between different maize genotypes as well as different nitrogen fertilizer levels and the interaction of nitrogen and genotype of maize was significant (*P*<.01) with 1000 kernel weight (Table. 3). The highest mean weight of all hybrids was in response to 200 kg ha^{-1} application of applied nitrogen fertilizer, whereas the lowest was with no (control) nitrogen fertilizers. The highest 1000 kernel weight was 335.33 g in ZP6468D hybrid with 200 kg ha^{-1} nitrogen fertilizer, whereas the lowest was in CADZ hybrid with no fertilizer, which was 231.33 ton ha^{-1}.

Table 3. The effect of different nitrogen fertilizers on 1000 kernel weight (g) in five different maize genotypes.

Cult. / N kg ha^{-1}	CADZ	DK 6050	DRACHMA	MYIMY	ZP6468D	Mean N
0	231.33 m*	238.33 m	237.33 m	232.66 m	260.00 l	239.93 E
50	237.33 m	292.33 e-i	269.00 j-l	260.66 kl	284.33 f-j	268.73D
100	274.00 j-l	280.33 h-j	301.00 c-f	275.00i-l	282.33g-j	282.53C
150	234.33 m	273.00 j-l	272.00 j-l	259.00 l	294.33 d-h	266.53 D
200	278.33 h-k	327.33 ab	294.33 d-h	302.33 c-f	335.33 a	307.53A
250	300.33 c-g	287.00 f-j	295.33 d-g	307.00 c-e	287.33 f-j	295.40B
300	269.00 j-l	315.00bc	286.00 f-j	311.66 b-d	308.00 c-e	297.93AB
Mean	260.66 C	287.61 A	279.28 B	278.33 B	293.09 A	

** : There is no statistical difference among values annotated with the same letter at the each row and column according to Duncan test at P≤.05*

Bhatt [36] revealed that adding different nitrogen doses affected significantly the 1000 kernel weight, in which applying 240 kg ha^{-1} of nitrogen per hectare had the highest effect on it in comparison to lower doses and control. This study agreed with the previous research findings.In contrast, the study of Worku et al. [20] showed the nitrogen levels and maize

UNDER PEER REVIEW

hybrids had significant effect on yield and yield contributing characteristics. Their study was undertaken in the Jabitahinan District - Amhara Region in farmer's field between 2014 and 2015. They revealed that applying nitrogen levels did not significantly affect the 1000 kernel yield but numerically did. In the present study, the application of nitrogen affected 1000 kernel weight significantly; therefore, this research is not in agreement with the work of Worku et al. [20].

3.4 Grain Yield (ton ha^{-1})

The effect of various nitrogen fertilizer amounts on different maize hybrids on grain yield is shown in Table 4. There were significant differences between different maize genotypes as well as different nitrogen fertilizer levels (P<.01) with total grain yield, but the interaction of nitrogen and genotype of maize was not significant. The highest mean yield of all genotypes was in response to 300 kg ha^{-1} application of applied nitrogen fertilizer, whereas the lowest was with no (control) nitrogen fertilizers. The highest grain yield was 17.68 ton ha^{-1} in DRACHMA hybrid with 300 kg ha^{-1} nitrogen fertilizer, whereas the lowest was in CADZ hybrid with no fertilizer, which was 8.07 ton ha^{-1}.

Qiu et al. [37] applied nitrogen fertilizer from 70 to 280 kg ha^{-1} nitrogen per hectare in three following years using different regions. It was found that the grain yield was increased significantly from control to 280 kg nitrogen per hectare in all the three years and the three used maize hybrids. This confirms similar results found in this research in which the grain yield increased from 9.08 tone ha^{-1} of non-fertilized plots to 15.95 tons per hectare of 300 kg ha^{-1} nitrogen fertilizers. Belay and Adare [21] used different nitrogen levels (50, 100 and 150 kg N ha^{-1}) on different maize genotypes at Haramaya, Eastern Ethiopia in years 2018 and 2019. They found that the total grain yield was increased significantly in both years with increasing nitrogen doses. In addition, Ványiné et al. [38] undertook a study in Hungary using different nitrogen levels and different maize hybrids found a significant effect of nitrogen on the total grain yield of maize. Similar results were found by Jena et al. [33] who stated that adding nitrogen dose had increased the grain yield significantly.

Table 4. The effect of various nitrogen fertilizer amounts on different maize hybrids on grain yield.

Cult. / N kg ha^{-1}	CADZ	DK 6050	DRACHMA	MYIMY	ZP6468D	Mean N
0	8.07 o	8.41 o	8.36 o	9.86 mn	10.68 lm	9.08 F
50	9.56 n	11.23 j-l	12.37 h-j	11.63 j-l	12.86 g-i	11.53 E
100	8.85 no	12.17 ij	13.99 e-g	11.33 j-l	15.94 bc	12.46 D
150	11.65 j-l	12.02 i-k	12.34 h-j	10.90 k-m	13.40 gh	12.06 DE
200	13.89 e-g	12.14 ij	17.44 a	13.38 gh	15.57 b-d	14.48 B
250	14.63 d-f	13.58 fg	11.63 j-l	14.65 d-f	13.33 gh	13.56 C
300	16.18 b	14.99 c-e	17.68 a	14.68 d-f	16.23 b	15.95 A
Mean	11.84 D	12.07 CD	13.40 B	12.35 C	14.00 A	

** : There is no statistical difference among values annotated with the same letter at the each row and column according to Duncan test at P≤.05.*

3.5 Total Chlorophyll (nm)

The response of the chlorophyll, using Spad-502, of different maize hybrids to different nitrogen levels is shown in Table (5a). There were significant differences between different

UNDER PEER REVIEW

maize genotypes as well as different nitrogen fertilizer levels (*P*<.01) and the interaction of nitrogen and genotype of maize was also significant (*P*<.01). The highest mean of all genotypes was in response to 300 kg ha^{-1} of applied nitrogen fertilizer, whereas the lowest was control without applying any fertilizers. The highest chlorophyll was in DRACHMA hybrid with 250 kg ha^{-1} nitrogen fertilizer, which was 59.53 nm, whereas the smallest was in MYIMY hybrid with no fertilizer, which was 33.7 nm.

Whereas, the response of the chlorophyll, using spectrophotometer, of different maize hybrids to different nitrogen levels is shown in Table (5b). There were significant differences between different maize genotypes as well as different nitrogen fertilizer levels (*P*<.05). The highest mean of all genotypes was in response to 300 kg ha^{-1} of applied nitrogen, whereas the lowest was control without applying any fertilizers. The highest chlorophyll was in MYIMY hybrid with 300 kg ha-^{1}nitrogen fertilizer, which was 49.36 nm, whereas the smallest was in DK6050 hybrid with no fertilizer, which was 20.33 nm.

Table 5a. The effect of different nitrogen levels on the total chlorophyll amount, determined with Spad-502, in five different maize hybrids.

Cult. / **N kg ha^{-1}**	**CADZ**	**DK 6050**	**DRACHMA**	**MYIMY**	**ZP6468D**	**Mean N**
0	38.83 pq	36.86 qr	39.93 o-q	33.70 r	36.96 qr	37.26 D
50	45.10 j-o	40.26 op	45.80 i-n	43.40 m-p	44.96 j-o	43.90 C
100	45.10 j-o	42.40 n-p	44.86 k-o	43.03 m-p	48.96e-l	44.87 C
150	48.23 f-m	47.70g-n	50.76 c-i	44.10 l-o	52.86 b-g	48.73 B
200	53.16 b-f	55.26 a-d	57.63 a-c	50.10 d-k	51.93 b-h	53.22 A
250	54.00 b-e	47.03 h-n	59.53 a	50.23 d-j	51.40 c-h	52.44 A
300	53.13 b-f	50.76 c-i	54.16 b-e	57.06 ab	55.10 a-d	54.04 A
Mean	48.22 B	45.75 C	50.38 A	45.94C	48.88 AB	

** : There is no statistical difference among values annotated with the same letter at the each row and column according to Duncan test at P≤.05.*

Table 5b. The effect of different nitrogen levels on the total chlorophyll amount, determined with spectrophotometer, in five different maize hybrids.

Cult. / **N kg ha^{-1}**	**CADZ**	**DK 6050**	**DRACHMA**	**MYIMY**	**ZP6468D**	**Mean N**
0	23.13 kl	20.33 l	24.93j-l	20.76 l	25.60 j-l	22.95 D
50	34.36 f-i	29.96 i-k	36.56c-i	33.20 g-i	30.00i-k	32.82 C
100	34.06 f-i	33.10 g-i	39.96b-g	34.73 e-i	41.56 b-f	36.68 BC
150	42.30 a-d	33.73 g-i	40.20b-g	40.50b-g	36.03 c-i	38.55 B
200	35.63 d-i	34.03 f-i	43.16 a-c	31.80 h-j	37.13 c-i	36.35 B
250	37.63 c-h	39.33c-h	36.13 c-i	39.13c-h	46.93 ab	39.83 B
300	49.33 a	42.13 b-c	47.26 ab	49.36 a	43.46 a-c	46.31 A
Mean	36.63 AB	33.23 C	38.31 A	35.64 B	37.24 AB	

UNDER PEER REVIEW

** : There is no statistical difference among values annotated with the same letter at the each row and column according to Duncan test at P≤.05.*

Abo El-Ezz and Haffez[22] found that applying nitrogen to maize increased total chlorophyll levels. The finding of the present study about chlorophyll is in agreement with the results of Abo El-Ezz and Haffez [22], in which the total chlorophyll is increasing with increasing applied nitrogen using both SPAD-502 and spectrophotometer methods. Similarly, Hokmalipour and Darbandi[39] used SPAD chlorophyll meter to measure total chlorophyll after applying nitrogen fertilizers to 180 kg ha^{-1}. They indicated that total chlorophyll was significantly increased by increasing the applying of nitrogen fertilizer. In another study by Ványiné et al. [38] undertaken in Hungary using different nitrogen fertilizer levels and different maize hybrids. It was indicated that the chlorophyll content was increased significantly in two consecutive years in 2009 and 2010 by applying nitrogen fertilizer. The results of this study are agreed with the previous studies findings. The rising trend of chlorophyll contents with increasing nitrogen level indicates superior nitrogen uptake by the maize plants, causing more greenish-leaves [40, 41].

3.6 Protein Content (%)

There were significant differences between different maize genotypes (*P*<.05) as well as different nitrogen fertilizer levels (*P*<.01), and the interaction of nitrogen and genotype of maize was significant (*P*<.01) with protein content (%). The largest mean of protein content was in response to 300 kg ha^{-1} of applied nitrogen fertilizer, whereas the lowest mean was in control (0 kg N fertilizer). The highest protein content was in DRACHMA hybrid with applying 300 $kgha^{-1}$ of nitrogen fertilizer, which was 8.51%, whereas the lowest ratio was 4.43% in CADZ hybrid with control, which is 0 kg nitrogen fertilizer application (see Table 6).

It is explained from the study of Aslam et al. [30] that the maximum protein was 9.14% by applying 150 kg of nitrogen ha^{-1}, while the minimum was 6.54%, which was obtained from the control with no nitrogen application. The maximum protein content produced by 150 kg N ha^{-1} was around 40% more than the protein content of control, and up to 10% more than 100 kg nitrogen per hectare protein content, and nearly 18% more than 50 kg of nitrogen ha^{-1} protein content. The increase in crude protein percentage of maize with the application of nitrogen had been also reported by other studies [42 – 46]. Therefore, the present study is consistent with the previous studies since protein content from 4.4% in control increased to 5.5% when 300 kg of nitrogen applied per hectare. In another study by Abo El-Ezz and Haffez[22] found that applying nitrogen to maize increased protein levels significantly.

Table 6. The effect of different levels of applied nitrogen fertilizers to the protein content of five maize hybrids.

Cult. / N kg ha^{-1}	CADZ	DK 6050	DRACHMA	MYIMY	ZP6468D	Mean N
0	4.43 m*	5.01 lm	5.95 i-j	5.60 j-l	5.95 i-l	5.39 C
50	6.06 h-l	5.48 kl	7.23 b-h	6.65 d-k	7.70 a-e	6.62 B
100	7.46 a-f	6.06 h-l	6.30 f-k	6.18 g-k	6.06 h-l	6.41 B
150	7.46 a-f	6.76 c-j	7.70 a-e	6.88 c-i	7.00 c-i	7.16 AB
200	6.76 c-j	7.11 c-i	6.53 e-k	6.76 c-j	7.11 c-i	6.86 B

UNDER PEER REVIEW

250	7.00 c-i	7.35 a-g	7.46 a-f	7.00 c-i	7.58 a-e	7.28 AB
300	7.58 a-e	7.81 a-d	8.51 a	8.40 ab	7.93 a-c	8.05 A
Mean	6.68 BC	6.51 C	7.10 A	6.783 A-C	7.05 AB	

** : There is no statistical difference among values annotated with the same letter at the each row and column according to Duncan test at P≤.05.*

3.7 Oil Content (%)

There were no significant differences between different maize genotypes as well as different nitrogen fertilizer levels (P>.05) with oil content, but the interaction of nitrogen and genotype of maize was significant (*P*<.01). The largest mean of oil content was in response to 50 kg ha^{-1} of applied nitrogen fertilizer, whereas the lowest mean was in both control (0 kg ha^{-1} N fertilizer) and 200 kg ha^{-1} of applied nitrogen fertilizer. The highest oil content was in MYIMY hybrid with applying 50 kg ha^{-1} of nitrogen fertilizer, which was 7.33%, whereas the lowest ratio was 4.16% in DK6050 hybrid with control, which is 0 kg ha^{-1} nitrogen fertilizer application. The highest mean of hybrids was in DK6050 while the lowest was in CADZ (Table 7).

Table 7. The effect of different levels of applied nitrogen fertilizers to the oilcontent of five maize hybrids.

Cult. / N kg ha^{-1}	CADZ	DK 6050	DRACHMA	MYIMY	ZP6468D	Mean N
0	5.00 c-f	4.16 f*	5.33 b-f	5.66 a-f	5.16 b-f	5.06 A
50	4.50 c-f	5.33 b-f	5.00 c-f	7.33 a	6.16 a-e	5.66 A
100	4.33 d-f	7.00 ab	5.16 b-f	4.83 c-f	4.83 c-f	5.23 A
150	4.66 c-f	6.33 a-c	5.83 a-f	4.00 f	5.50 a-f	5.26 A
200	4.33 d-f	4.50 c-f	5.83 a-f	6.oo a-e	4.66 c-f	5.06 A
250	5.83 a-f	5.16 b-f	5.16 b-f	4.83 c-f	4.66 c-f	5.13 A
300	6.16 a-e	5.00 c-f	4.50 c-f	4.33 d-f	5.66 a-f	5.10 A
Mean	4.95 A	5.35 A	5.26 A	5.28 A	5.23 A	

** : There is no statistical difference among values annotated with the same letter at the each row and column according to Duncan test at P≤.05.*

Abo El-Ezz and Haffez[22] found that applying nitrogen to the maize had increased oil levels significantly, in which oil content increased from 2.03 to 2.87% with applying 150 kg N ha^{-1}.The present study is consistent with the study of Abo El-Ezz and Haffez [22] in which in the present study the oil content increased from 4.16 in control to 7.31% with applying nitrogen fertilizer.

4. CONCLUSION

From the present study, in which the effect of different nitrogen levels on various maize varieties was studied, it can be concluded from the result obtained that there were significant differences among different maize varieties in response to different nitrogen levels. In addition, different nitrogen levels affected considerably on maize characteristics. Furthermore, the effect of interaction between nitrogen and maize genotype was significant in most of the studied traits.

UNDER PEER REVIEW

In general, increasing the amount of nitrogen per hectare had better effect on studied characteristics of different maize varieties, in which in most of the cases, adding 300 kg nitrogen had optimum results.In considering the response of maize varieties to nitrogen, the best variety was DRACHMA genotype while the worst variety was CADZ genotype, however this hybrids was superior in some traits.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

UNDER PEER REVIEW

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